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THE EMBRYOLOGY OF THE SHEPHERD'S PURSE.*

(A Posthumous Paper.)

MABEL SCHAFFNER.

The embryo of the shepherd's purse (*Bursa bursa pastoris* (L.) Britt.) has had an important place as a representative dicotyl in most botanical textbooks. The original investigations of Hanstein (1) and Famintzin (2) were superior and epoch-making for their day, yet many points were left obscure and some of these are still unsettled, as a reference to the various botanical textbooks will show. Considerable variation has been reported as to the succession of the cell divisions and other minor [illegible]. The best recent account is by Coulter and Chamberlain [illegible] and what is given below is practically a confirmation of [illegible] port with a few differences in details.

The embryology of Alyssum as given by Miss [illegible] shows several interesting deviations from the Bursa [illegible] makes it clear that generalizations can not be made [illegible] knowledge even in the case of closely related plants.

It was my intention to make a complete study of the embryo of Bursa and to prepare a series of drawings on the same scale of magnification in order that not only the succession of cell divisions and the development of the several embryonic tissues be apparent but also the actual increase in size of the embryo as a whole and of the cells at various stages of development.

The ordinary methods of killing and imbedding were employed and the serial sections, cut 10–12 mic. thick, were stained on the slide. Delafield's haematoxylin makes a very satisfactory stain properly employed.

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*Contributions from the Botanical Laboratory of the Ohio State University, XXV.

The egg apparatus of Bursa is well organized and after fertilization the oospore elongates considerably and divides by a transverse wall into two cells of unequal size (Figs. 1--5). The basal cell does not divide again but begins to enlarge rapidly, finally developing into a large vesicular cell which is closely surrounded by the upper part of the wall of the ovule and continues in an active condition until the seed ripens. The upper cell divides by a transverse wall giving rise to a proembryo of three cells, the terminal cell, an intermediate cell, and the basal vesicular cell (Fig. 6). The next division is again transverse and probably takes place in the intermediate cell (Fig. 7). After a filament of four cells is produced, the apical or terminal embryo cell divides by a longitudinal wall, giving rise to the typical five-celled embryo (Fig. 8). The f[illegible]owing division occurs in the suspensor cell next to the vesicular cell, resulting in a six-celled embryo with five tiers (Figs. 9–11). Often the cell below the two terminal embryo cells stains dark like them while the three suspensor cells take a much lighter stain (Figs. 10,11). This would indicate that this cell is the second cell of the embryo proper and that it does not contribute to the further development of the filamentous suspensor until its division at a much later stage. This point was, however, not determined. The two terminal cells now divide by longitudinal walls at right angles to the previous division giving rise to the terminal quadrants while further transverse divisions occur in the suspensor (Figs. 12–15).

At the time when the terminal quadrants divide by transverse walls to form the octants, the suspensor usually consists of the vesicular cell and six intermediate cells (Figs. 16–20) and this is frequently the extent of this org[illegible] though more commonly there [illegible] or eight intermediate suspensor cells developed. The [illegible] and hypocotyledonary rgeions of the embryo are [illegible]tely separated by the divisions which give rise to the oc[illegible]. The octants soon cut off dermatogen cells by periclinal walls thus producing a nearly spherical body of sixteen cells (Figs. 17, 18). The periclinal divisions which give rise to the [illegible] appear first in the terminal octants (Fig. 17). At [illegible] the proembryo consists typically of twenty-two or [illegible]y-three cells. While the dermatogen cells are continuing [illegible] divisions by anticlinal walls the eight inner cells divide by [illegible] walls and the cell between the suspensor proper an[illegible] [illegible]inal sphere divides by a transverse wall into th[illegible] [illegible] and a very flat disk-like suspensor cell wh[illegible] [illegible] the development of the embryonic tissues [illegible] [illegible] primary dermatogen begins its further developm[illegible] [illegible] quadrants of cells and as would be expect[illegible] [illegible] in these cells is more active during the fur[illegible]

the embryo than in the lower quadrant. Frequently the formation of anticlinal walls in the dermatogen is delayed until after the division of the upper suspensor cell (Fig. 20).

The entire embryo is, therefore, developed from the two cells at the outer tip of the proembryo, the terminal cell, as will appear later, giving rise to the cotyledons, stem tip and hypocotyl while the basal cell after cutting off one suspensor cell gives rise to the calyptrogen, root tip, and calyptra.

The further development of the embryonic sphere is by the division of the lower tier of inner cells by transverse walls. There are then three tiers of cells in the sphere besides the dermatogen (Figs. 24–28). These divisions were established by the presence of spindles in the lower tier as in Fig. 24. Frequently also the outer tier of cells takes a much deeper stain than the other two tiers as is shown in Fig. 28. When these divisions begin the basal embryo cell divides by a transverse wall, the resulting cells being the incepts of the growing point of the root tip and the calyptrogen (Figs. 24–26). The upper cell, usually lenticular in shape, divides first forming a plate of four cells by the development of longitudinal walls (Fig. 28). These four cells remain dormant for some time but continue division before the embryo reaches maturity.

The two lower tiers in the embryonic sphere now begin to differentiate into a central plerome and the surrounding periblem and at the same time the lowest cell of the embryo proper or the incipient calyptrogen cell divides by longitudinal walls into four cells followed by transverse or periclinal walls which differentiate the primary layers of the calyptra and calyptrogen (Figs. 29–3[illegible]). This periclinal division extends out into the dermatogen cells derived from the primary octant as will appear from a comparison of Figs. 29, 30 and 32. The calyptrogen thus [illegible] from cells derived from both he terminal and basal [illegible] As stated before the embryo proper is develope[illegible] two original tiers of cells each developing octant[illegible] minal cell divides first by longitudinal walls and [illegible] ment is far advanced before the basal cell begins it[illegible] which is always transverse in Bursa although [illegible] Alyssum.

The cotyledons and plumule have their origi[illegible] cells of the original octant while the hypocot[illegible] from the basal octants. The nearly spherical em[illegible] [illegible] a flattened appearance at the outer end (Fig[illegible] [illegible] the appearance of two large protuberan[illegible] [illegible] cotyledons, it is heart-shaped in properly cut [illegible] [illegible] The embryo remains straight until by rap[illegible] [illegible] cotyledons are forced around by the curved wall of the [illegible] When the embryo is approaching maturit

cells of the hypocotyledonary region and root tip undergo rapid division so that the entire length of the cavity of the ovule is filled and the suspensor cells are crushed (Figs. 35, 37). But the vesicular cell retains its active appearance to the end.

The plerome consists of a bundle of small elongated cells surrounded by a sheath of larger cells and the periblem consists of two layers with an inner limiting layer. The sheath of the plerome and the inner layer of the periblem have a common origin as will appear from an inspection of Figs. 36 and 38. The nature of these two layers was not determined. In the mature embryo the cotyledons are well developed but it is difficult to obtain central sections because of the curving and folding. Usually when one has a central section of the radicle the sections of the cotyledons will be more or less tangential.

ADDENDUM.

The foregoing paper was left in an incomplete condition at the time of my wife's untimely death. It was her desire to work out the embryogeny of Bursa step by step as a preliminary to other embrylological studies which she had begun. However, the work was so nearly complete that it was thought advisable to publish it as it was left although a few spindle stages are lacking for a complete series. Just before her last sickness she had prepared material collected at various times of the day and night in the hope of being able to fill out the missing stages.

The series of figures, all drawn on the same scale, represent to the eye the actual increase of the embryo in size at each stage of development, and will be of considerable use to students for [illegible]

[illegible] cut off in the midst of work and plans for the future [illegible], and, without referring to my personal loss, it is [illegible] heart that I contemplate her passing away so [illegible] hopes and ambitions were realized.

JOHN H. SCHAFFNER.

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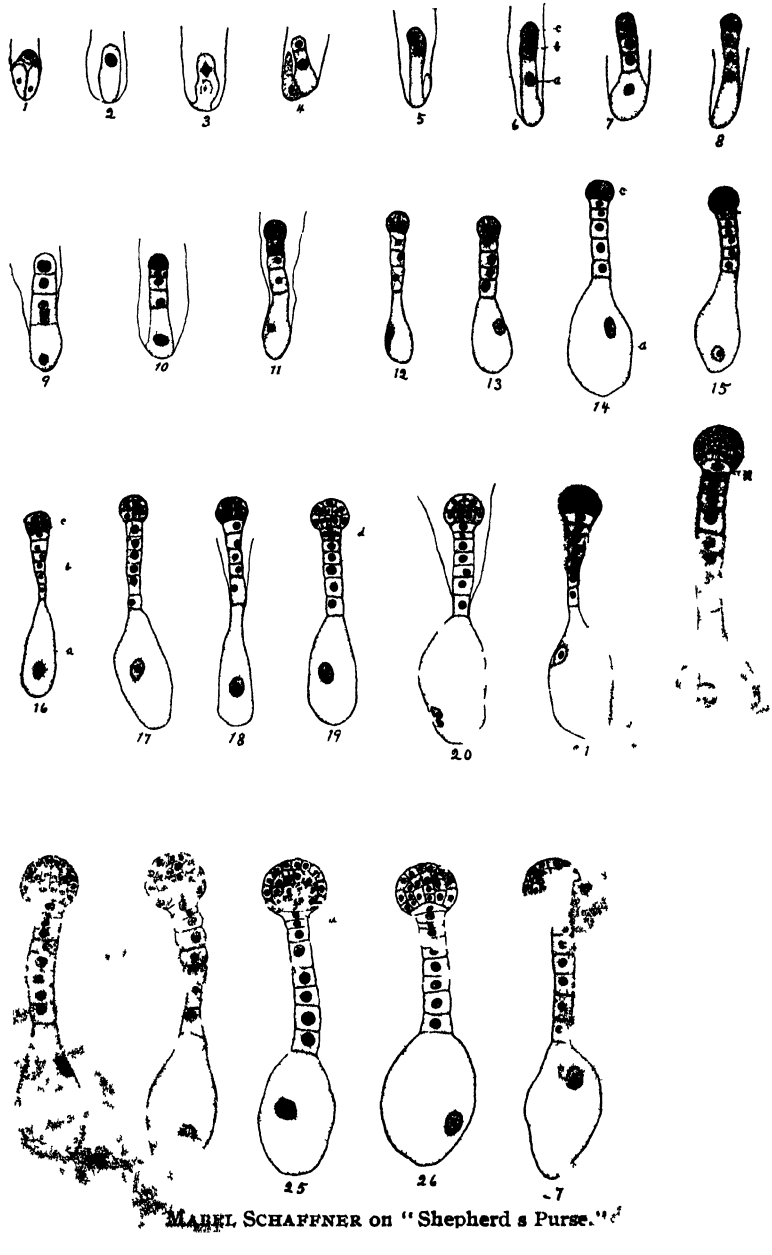
[illegible] C. The Embryology of Alyssum. Bot. [illegible] 324. [illegible]8.

[illegible] J. M., AND CHAMBERLAIN, C. J. Morphology [illegible] Sperms. [illegible] 196, 1903.

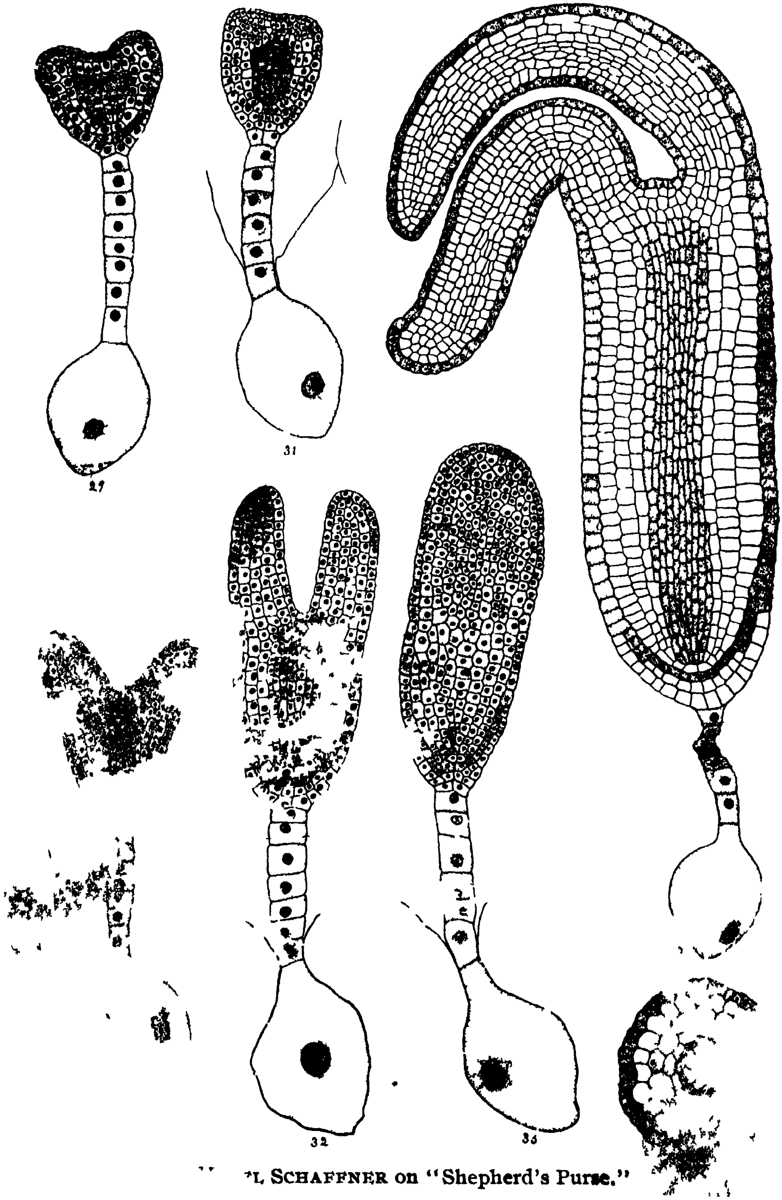
[illegible] C. J. Methods in Plant Histology [illegible]

OHIO NATURALIST *Plate I*



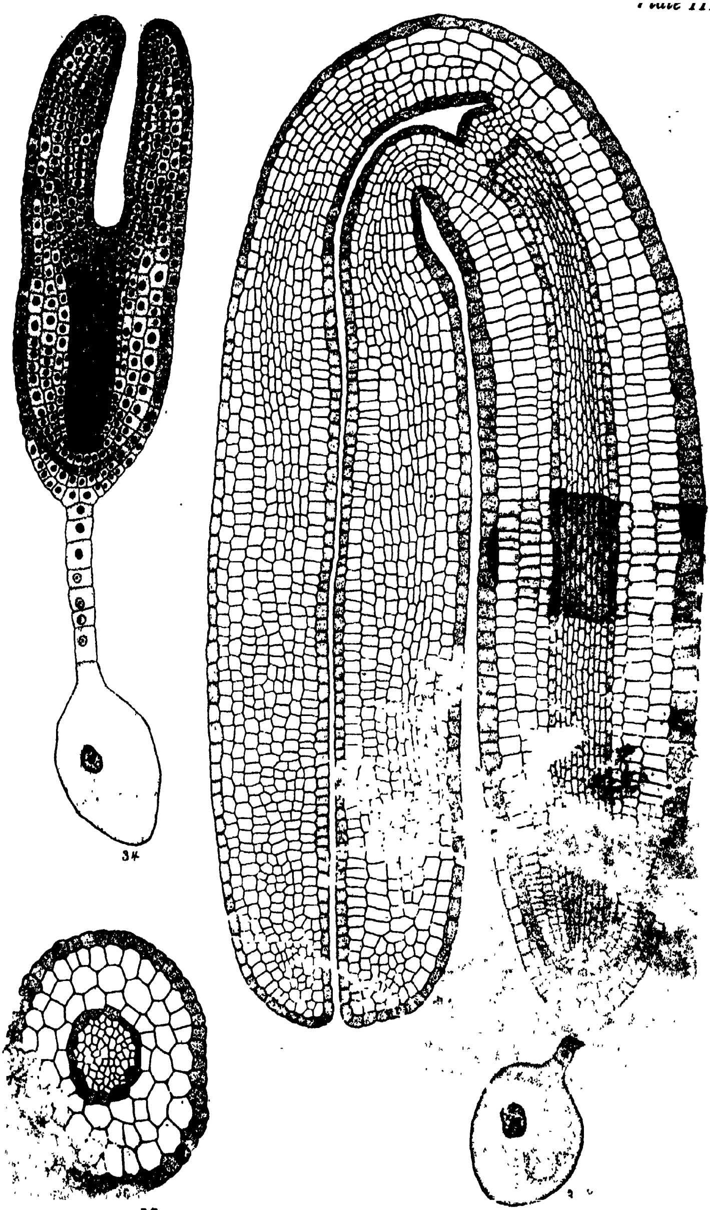
MABEL SCHAFFNER on "Shepherd s Purse."

OHIO NATURALIST *Plate II.*



SCHAFFNER on "Shepherd's Purse."

OHIO NATURALIST. Plate III.



MABEL SCHAFFNER on "Shepherd's Purse."

Explanation of Plates I, II, and III.

The drawings are all on the same scale and were reduced to $\frac{1}{5}$ of their original size. A combination of Zeiss 18 compensating ocular and Zeiss 8.0 mm. Apochromat objective was employed with a magnification on the table of about 900.

1. Egg apparatus with oosphere.
2. Elongated oospore.
3. Oospore dividing.
4. Two-celled embryo and synergid.
5. Two-celled embryo.
6. Three-celled embryo.
7. Four-celled embryo.
8. Five-celled embryo.
9. Incipient six-celled embryo.
10. Six-celled embryo.
11. Older six-celled embryo with the upper two tiers of cells stained much darker than the rest.
12. Eight-celled embryo; the tip in the quadrant stage.
13. Nine-celled embryo with four-celled tip.
14. Ten-celled embryo with four-celled tip.
15. Eleven-celled embryo with four-celled tip.
16. Fifteen-celled embryo with octants at the tip and seven suspensor cells.
17. Same stage as the preceding, the octants cutting off the primary dermatogen.
18. Twenty-two-celled embryo with primary dermatogen complete, the normal embryo at this stage has twenty-three cells.
19. Embryo with the cell adjoining the embryonic sphere undergoing transverse division.
20. Typical twenty-four-celled embryo.
21. Embryo with longitudinal division beginning in the lower tier of the inner octants.
22. Typical embryo with ten-celled suspensor.
23. Somewhat later stage showing rapid multiplication of the upper dermatogen cells.
24. Embryo [illegible] division of the basal embryo cell and origin of the third [illegible] the embryonic sphere.
25. Typical [illegible] at time when the lower two embryo cells are ready for further [illegible].
[illegible] preceding but somewhat one-sided in development [illegible] different number of cells in the suspensor.
27. Embryo [illegible] first division [illegible] the root tip cell.
28. [illegible] ing the [illegible] from which the cotyledons [illegible] a much darker stain than the rest [illegible] the tis[illegible]
[illegible] yo [illegible] yledons, stem tip, hypocotyl, root tip, [illegible]
[illegible] than the preceding showing further devel[illegible]
31. [illegible] embryo cut in same plane as the cotyledons.
32. Embryo showing cells of stem [illegible] second division of calyptrogen.
33. Longitudinal section through [illegible] cotyledon of embryo somewhat older than the [illegible]
34. [illegible] the final rapid elongation [illegible]
[illegible] embryo showing the condition of the tissues at the stage [illegible] cotyledons begin to curve.
36. Cross section of embryo at same stage as the preceding show[illegible] dermatogen, periblem and plerome.
[illegible] embryo showing the character of the embryo[illegible]
[illegible] Cross section of mature embryo.

SOME GUATEMALAN ORTHOPTERA, WITH DESCRIPTIONS OF FIVE NEW SPECIES.

LAWRENCE BRUNER.

The twenty-eight species of Orthoptera reported in this paper were collected during the winter of 1905 by James S. Hine, of Columbus, O., who referred them to the writer for determination. Although the collection is but a small one it is very interesting since it contains specimens of at least four species which appear to be new to science and others that materially extend the range of known forms. One of the new species, *Cornops scudderi*, adds a South American genus hitherto not reported for North America.

Family BLATTIDAE.

1. **Pseudophyllodromia venosa** Sauss. This insect is represented by a single specimen taken at Mazatenago, February 3.
2. **Blabera trapezoidea** Burm. A single male of this large cockroach was collected at Santa Lucia February 1.

Family MANTIDAE.

3. **Stagmomantis dimidiata** Burm. The species is represented by a fine male which was captured March 5, at Puerto Barrios. A female nymph that was taken at San Jose on February 5 is also referred here.

Family GRYLLIDAE.

4. **Oecanthus nigricornis** Walk.(?) The collection contains two males of a tree-cricket which were taken on February 7, at Amatitlan. One of these has the greater portion of the antennae pale testaceous instead of black, as described by Walker. Both, however, lack the black lines or dots on the two basal antennal joints, thereby agreeing with the insect that Henri de Saussure takes to be Walker's *nigricornis*, but perhaps erroneously, as the types of Walker's insect came from Illinois.
5. **Oecanthus varicornis** Walk.(?) A single [illegible] antennal joints unifasiate with black, [illegible] ing very closely with the preceding, is referred [illegible] at the same time and [illegible]
6. **Paroecanthus aztecus** Sauss. The [illegible] species comes from Gualan where [illegible]

Family LOCU[illegible]

7. **Hormilia tolteca** Sauss. Three specimens [illegible] are at hand from Mazatenango. The [illegible]
8. **Orophus conspersus** Brunn. A single female of [illegible] at Mazatenango on February 8.
9. **Orophus tessellatus** Sauss. [illegible] single female taken labelled as coming from San [illegible]
10. **E[illegible]lus consobrinus** Sauss. [illegible] species was taken at Santa [illegible]
11. [illegible]**ysdrus infirmus** Sauss. et Pict. The collection contains a [illegible] is delicate species. They come from Mazatenango, and were captured February 3.
12. **[illegible]thron atrispinum** Stal. The insect [illegible] is a little large as compared with the measurements given in Brunner's monograph [illegible] Pseudophyllidae, but it agrees in other res[illegible] Stal's *[illegible]dius atrispinosus*. It comes from San[illegible] where it was taken February 1.

Family ACRIDIIDAE.

13. **Paratetix mexicanus** Sauss. The collection contains a single male specimen of this species. It was taken on March 8, at Puerto Barrios.

14. **Tettigidea chichimeca** Sauss. A single female specimen represents the present species so far as the collection now before me is concerned. It also comes from Puerto Barrios, where it was taken on the same date as the last.

15. **Amblytropidia costaricensis** Bruner. The only representative of this rather common genus in tropical America is a single specimen of *A. costaricensis*. It was taken February 7, at Amatitlan.

16. **Orphula guatemalae** n. sp. Most nearly related to *O. azteca* Saussure, but differing from it in its smaller size and slenderer form. It differs also in the female by having a more uniform color—the tegmina maculations are fewer and smaller, and the basal joints of the antennae are less depressed. The hind femora of both sexes are also shorter and more graceful. The valves of the ovipositor are shorter and slenderer than in *azteca* or *meridionalis*. In its general color the present species varies from pale testaceo-ferruginous to dark brown in the female, while the males have the dorsum of occiput, pronotum and tegmina testaceous or green. In the male the sides of the head, pronotum, pleura and costal and discal field of tegmina are unspotted brown; the lateral pronotal carinae are edged below with dark piceous in both sexes. Abdomen venter and face pale testaceous, the legs a little darker and somewhat infuscated at the knees. Sides of basal abdominal segments of male more or less piceous.

Length of body, ♂, 15.5 mm., ♀, 22.5 mm.; of pronotum, ♂, 3 mm., ♀, 4 mm.; of tegmina, ♂, 13,25 mm., ♀, 17 mm.; of hind femora, ♂, 9.5 mm., ♀, 12.25 mm.

Habitat. The types, male and female, come from Santa Lucia where they were collected February 1. The collection also contains an additional female from the same locality and a pair from Mazatenango, February 3.

The following table will show the realtionship of the species:

SYNOPTIC TABLE OF THE SPECIES OF ORPHULA.

A1 Fastigium of the vertex with its antero-lateral egdes decidedly rounded. Basal joints of antennae greatly depressed. Lateral carinae of the pronotum only gently divergent on the hind lobe. PAGANA Stal.

2. Fastigium of the vertex with its anteor-lateral edges nearly ... straight. Basal joints of the antennae only gently depressed. Lateral carinae of the pronotum strongly divergent on the hind lobe.

b[1] L[illegible]al carinae of the anterior lobe of the pronotum [illegible] (Costa Rica) MERIDIONALIS Bruner

[illegible] crainae of the anterior lobe of the pr[illegible]tum [illegible]ergent.

[illegible] more robust (Mexico southerly) AZTECA Sauss

[illegible] and rather slender (Guatemala) GUATEMALAE n. sp.

[illegible] [illegible]ctata Walk.(?) There are four specimens, 1 female and 3 males, of a locust that are doubtfully referred to Walker's [illegible]ctata. They come from San Jose, where they were taken on February 5.

Orphulella meridionalis Bruner. One male and one [illegible] Barrios, March 3.

19. **Orphulella walkeri** n. sp. Below medium in size, rather slender, the antennae of male graceful and decidedly longer than the head and pronotum combined. Color variable, ranging from testaceous to green varied with brown and black.

Eyes prominent, considerably (♂) or a trifle (♀) longer than the cheeks below them; fastigium of the vertex with the sides parallel two-thirds its length, acuminate even in the female and unusually deeply sulcate, lateral foveolae well defined, elongate triangular; frontal costa prominent above the ocellus where they are coarsely and paucily punctate; face rather oblique; antennae long and slender. Pronotum slightly expanding posteriorly, the two lobes about equal in length, the lateral carina in advance of the last transverse sulcus straight and very gently diverging anteriorly. Tegmina in the female provided with two rows of cells, of moderate width and gently surpassing the apices of the hind formora in both sexes, in the female rather sparsely and evenly maculate with fuscous, in the male unspotted but with the dorsal field pale testaceous, the hind femora without markings or bands save for the knees which are infuscated apically. Wings infuscated or cloudy.

Length of body, ♂ 13.5 mm., ♀ 19 mm.; of antennae, ♂ 6.5 mm., ♀ 6 mm.; of pronotum, ♂ 2.5 mm., ♀ 3.95 mm.; of tegmina, ♂ 11.5 mm., ♀ 14.3 mm.; of hind femora, ♂ 9.25 mm., ♀ 10.55 mm.

Habitat. The types, ♂ and ♀, were collected February 22, at Los Amates, while an additional male was taken at Puerto Barrios, on March 3.

If we should attempt to run this insect out by the synoptic table as given by the author in the "Biologia Centrali Americana, Orthopt. II, pp. 74–78," it would fall into the section A² under b² along with *prominula* and *robusta*, but the table would have to be modified as follows:

b². Lateral carinae of the pronotum not arcuate, either straight throughout or parallel on the anterior lobe and more or less divergent on the posterior one.

- c¹. Antennae of the male more than ordinarily heavy; the insects rather robust.
  - d¹. Lateral carinae of the pronotum gently and evenly divergent posteriorly. Eyes prominent, elongate. Face strongly oblique. PROMINULA Bruner.
  - d². Lateral carinae of the pronotum divergent on the posterior lobe only. Eyes less prominent, subglobular. Face only moderately oblique. ROBUSTA [illegible]
- c². Antennae of the male filiform, slender. The [illegible] rather graceful. WALKERI n. sp.

This might be one of Walker's species of [illegible]*obothrus* which he described in the Catalogue of the Derma[illegible] Saltatoria in the British Museum. It is almost imp[illegible] determine his species from the meager descr[illegible]

20 **Heliastus guatemalae** Sauss. Several spec[illegible] are in the collection. They come from Ama[illegible] Fe[illegible] and Jan Jose, February 5. They do not diff[illegible] very [illegible] general color and form from *H. sumichrasti* Sau[illegible] of the wings of guatemalae is yellow instead of red.

[illegible] **minor** n. sp. Very similar in form to *A*[illegible] Walker, but differing from it in the much smaller s[illegible] absence of the pale band along the sides of the head, [illegible] and pleura. The last ventral segment of the [illegible] is also quite different.

Fastigium of the vertex elongate, triangular, with a moderately broad but shallow median longitudinal sulcus, the apex slightly acuminate; frontal costa rather deeply sulcate, widened above the antennae, nearly equal below, the face unicolorous, impunctate, strongly oblique; antennae only a trifle longer than the head and, pronotum taken together; eyes moderately prominent, a little less divergent than in the males of *A. chlorizans*, about twice the length of that portion of the cheeks below them. Pronotum subcylindrical, rather closely and finely punctate, much more closely so in front and on the hind lobe, the latter with a prominent median carina and short shoulders, about four-fifths as long as on the anterior lobes. Tegmina narrow, extending one-fifth of their length beyond the apex of the abdomen Hind femora slender, smooth, as long as the abdomen. The latter graceful, tapering, the last ventral segment short and provided with a lateral blunt tooth at each side, the center prolonged into a short boot-like projection in which the toe is directed to the rear. Hind tibiae slender, the lateral carinae poorly developed as compared with some of the other species of the genus. Prosternal spine slender, straight, the apex evenly rounded.

General color pale grass-green above, yellowish white below. Wings caerulean, the dorsum of the abdomen leaden gray. Antennae ferriginous, clypeus, labrum, tip of last ventral segment and hind tarsi pink.

Length of body, 22 mm , of antennae, 7 mm., of pronotum, 3 65 mm., of tegmina, 20 mm., of hind femora, 11 5 mm.

Habitat A single male from San Jose, February 5.

This genus appears to be represented by quite a number of species—a dozen or more—when we consider the two Americas. They fall into two well defined sections or possibly into distinct genera

22. **Arnilia** sp. The collection also contains a single female specimen of what appears to be a second species of *Arnilia*; but, since there are at least a half-dozen distinct species of similar size at hand as I write, it is difficult to definitely place it with certainty. The characters, so far as observed, are more pronounced in the males, and until I have had an opprotunity to critically study the dozen or more species of the genus of which I have specimens no attempt will be made to determine the individual just referred to It was taken February 6, at Amatitlan.

23. **Inusia obscura** (Thunb) (?) Two pairs of a slender locust taken at Los Amates, February 25 27, are referred with some doubt to Thunberg's *Acridium obscurum* Whether th[illegible] insect or not, they belong to Giglio-Tos' genus *Inusia* [illegible] two or three representatives in tropical Ameri[illegible]

24. **Cornops scudderi** n. sp A moderately robus , med[illegible] sized, grass-[illegible] and testaceous insect with a broad [illegible] band on e[illegible] [illegible] [illegible] from the back edge of the eyes along the upp[illegible] [illegible] pronotum and pleura and is bordered below by [illegible] of greenish yellow. The costal margin an[illegible] [illegible] are dark brown or fuscous

Head somewhat wider than the front edge of the pronotum; eyes a little [illegible] strongly divergent, a trifle longe[illegible] [illegible] below the vertex nearly as [illegible] [illegible] the tip of the [illegible] long, somewhat depressed [illegible] prominent, a little widest above the ocelli [illegible]

coarsely but shallowly punctate, as is in fact the whole face, the punctures brown; occiput rather long, the eyes distant from the front edge of the pronotum; antennae filiform, nearly as long as the hind femora, the basal joint robust and green, the balance brown. Pronotum subcylindrical, the surface coarsely punctate, on the anterior lobe distantly, on the hind lobe rather closely; front margin rather broadly rounded, hind margin widely obtuse angulate, anterior half of lower edges obliquely truncate; transverse impressed lines continuous, profound, the hind lobe much shorter than the anterior one, the median carina distinct throughout but most apparent on hind lobe. Tegmina of medium width, extending a little beyond the apex of hind femora, their tpis rounded, with the upper portion a little truncate. Hind femora robust extending one-fourth their length beyond the tip of abdomen; hind tibiae seven-spined on the outside. Abdomen tapering, the last ventral segment short, upturned and contracted to a narrow prow-shaped projection; the supra-anal plate broader than long, the sides of basal two-thirds broadly rounded and strongly convergent, the apical third with straight sides and evenly rounded apex, middle of basal portion provided with two parallel lines and the sides with two dots of black; cerci of the usual form for this group.

Length of body, 18 mm., of pronotum, 3.8 mm., of tegmina, 16 mm., of hind femora, 11 mm., of antennae, 10 mm.

Habitat. The single male type was taken March 11, at Puerto Barrios.

25. **Vilerna aeneo-oculata** DeG (?) Two males and two females of this genus are at hand from Mazatenango. They were taken March 3.

Saussure described an insect under the name of *Xipicera pygmaea* (Revue et Magasin de Zoologie, Mars 1861, p. 131.) and gave as its habitat simply "Mexico." A specimen bearing Saussure's label is before me as I write. It is a *Vilerna* and undoubtedly distinct from *aeneo-oculata*. The four Guatemalan specimens in the present collection are distinct from Saussure's and are fererd with some doubt to DeGeer's species from South America.

26. **Schistocerca pyramidata** Scudd (?) There are specimens of a large *Schistocerca* in the collection from Los Amatas, which are placed here with some doubt. They were collected February 20. These insects vary from pale rufo-testaceous with scarcely any tarce of maculation to dark gray-brown and strongly maculate on the tegmina—nearly or quite as plainly as *S. vaga* Scud.

27. **Aidemona azteca** Sauss. There are four specimens of this very common and widely dispersed locust in the co[illegible] taken at Mazatenango on the 3rd of February.

28. **Osmilia tolteca** Sauss. Every locality in southern [illegible] ward to Costa Rica, contains plenty of specimens of [illegible] It is represented by about a score of individua[illegible] calities where Orthoptera were taken by Prof [illegible]

University of Nebraska, Lincoln.

LIST OF ORTHOPTERA COLLECTED IN GUATEMALA BY C. C. DEAM AND E. B. WILLIAMSON.

A N CAUDELL

Tryxalis brevicornis Linn one female
Orphulella neglecta Rehn, two males and two females
Orphulella punctata DeGeer, three females
Heliastus guatemalae Sauss two males and two females
Heliastus sumicrasti Sauss three males and two females
Osmilia tolteca Sauss, one male and three females
Schistocerca vaga Scudder, one female

Besides the above adult forms, there are six young nymphs of a species of Dictyophorus thirteen nymphs of Heliastus, and one young locustian nymph

Washington, D C

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KEY TO THE FAMILIES OF OHIO LICHENS.

J C HAMBLETON

1 Fruiting thallus with apothecia or perithecia containing asci, Ascomycetes living symbiotically with algae ASCOLICHENES 2
1 Fruiting thallus not with apothecia nor perithecia spores produced on basidia Basidiomycetes living symbiotically with algae BASIDIOLICHENES 3
2 Fruiting body an apothecium DISCOLICHENES 4
2 Fruiting body a perithecium PYRENOLICHENES 23
3 Hymenium on an exposed surface (none in our territory) HYMENOLICHENES
3 Hymenium lining closed cavities (none in our territory) GASTROLICHENES
4 Paraphyses forming a powdery mass with the spores disc of apothecium more or less open The paraphyses growing beyond the asci forming there a network adhering to the disc of the apothecium which soon breaks up into a powdery mass with t[illegible] Algae belonging to the Chlorophyceae CONIOCARPINEAE [illegible]
4 Paraphyses not forming a powdery mass at the s[illegible]
5 Apothecia borne on a stipe exciple with [illegible] ... ceous or hypophloedal without cortic[illegible]
5 Apothecia sessile exciple with algae [illegible]
6 Disc of apothecium linear elin[illegible] or som[illegible] longing to Chloroph[illegible] [illegible]RAPHIDAE
6 Di[illegible] of th[illegible] ecium [illegible] Chloroph[illegible] [illegible] [illegible]OCARPAE
7 Apoth[illegible] [illegible]t border [illegible]
7 Apot[illegible] [illegible]GRAPH[illegible]
8 Spores unise[illegible]te [illegible]
[illegible]es one [illegible] d multiseptate [illegible]uniform [illegible] brownish [illegible]lls always th[illegible] [illegible]
9 S[illegible] s colorl[illegible] thall[illegible] [illegible] or fruticose [illegible]
9 Spores bro[illegible] [illegible]
10 Th[illegible] is foliose [illegible] ticose [illegible] rtic[illegible] layer, [illegible] sidial

10. Thallus crustaceous, ovate or lobed at the border, without cortical layer; pycnidia exobasidial. BUELLIACEAE.
11. Thallus when moist, more or less gelatinous, usually unstratified, scaly, foliose or fruticose, seldom crustaceous; apothecia sessile; alga a Nostoc. COLLEMACEAE.
11. Thallus when moist not gelatinous nor swollen. 12.
12. Thallus crustaceous, border lobed, horizontal. 13.
12. Thallus squamulose or foliose, horizontal or with border elevated; fastened to the substratum with rhizoids or umbilicus; pseudoparenchymatous throughout, or with cortical layer above or on both sides. 19.
12. Thallus cylindrical or fruitcose, upright or pendant; fastened to substratum with an anchor disc, or dying off from the ground growing radially, entirely covered with cortical layer. USNEACEAE.
13. Thallus with algae belonging to Chroolepus or Phylactidium. 14.
13. Thallus with algae belonging to Pleurococcus or Palmella. 15.
14. Exciple usually without algae, rarely rudimentary or wanting. LECANACTIDACEAE.
14. Exciple with algae always present, apothecia single or in groups sunken in thalline warts. THELOTREMACEAE.
15. Ascus one to eight spored, seldom sixteen to thirty-two, apothecia with distinct border or margin. 16,
15. Ascus many spored. ACAROSPORACEAE.
16. Exciple without algae. 17.
16. Exciple with algae, apothecia lecanorine. 18.
17. Apothecia sessile. LECIDEACEAE.
17. Apothecia borne on a stipe. CLADONIACEAE.
18. Apothecia sessile, border distinct. LECANORACEAE.
18. Apothecia single or in gropus, sunken in thalline warts; border usually very small. PERTUSARIACEAE.
19. Apothecia in young stage or always with the entire under side buried in the thallus; without margin, or bordered with the remains of the old covering. PELTIGERACEAE.
19. Apothecia on well defined stipes which are often strongly expanded and branched; naked or covered with thalline scales CLADONIACEAE.
19. Apothecia sessile or short stalked; margin distinct 20.
20. Interior hyphal layer wanting or indistinct; thallus entirely or in great part pseudoparenchymatous, with algae belonging Scyto[illegible], pycnidia exobasidial. HEPPIACEAE.
20. Interior hyphal layer distinct in the well stratified thallus. 21
Spores more or less spindle form, multiseptate, colorless or brownish [illegible] under side of thallus with abundant cyphellae or pseudocyphellae STICTACEAE.
Spores [illegible] ellipsoid, or long ovate, one-celled (by exception two-celled), or muriform, in [illegible] latter case they are dark colored; cyphellae never presen[t] 22.
Thallus with algae belonging to Scytonema. [illegible]
Thallus always with algae belonging to Pleu[rococcus] or Palmella apothecia sessile with algae in [illegible] [illegible]ELIACEAE.
[illegible] perithecium simple [illegible] divided [illegible] complete or incomplete partitions
[illegible] perithecium divided by complete or incomplete partitions:
[illegible] Palmella or Chroolepus. MYCO[illegible]RACEAE.
[illegible] or scaly, with cortical layer on [illegible] sides [illegible] upper [illegible] algae Pleurococcus [illegible] [illegible]ATOCARPACEAE.
[illegible]ceous, without cortical layer or with amorphous cortex [illegible] of horizontal hyphae. 25.

25. Perithecia inclined or horizontal, the ostioles usually opening into a common canal; situated in a stroma; algal cells Chroolepus. ASTROTHELIACEAE.
25. Perithecia erect with a single ostiole at the summit 26.
26. Perithecia in a stroma; algal cells belonging to Chroolepus. TRYPETHELIACEAE.
26. Perithecia single; storma wanting. 27
27. Spores one-celled (in our species), algae belonging to Pleurococcus or Palmella. VERUCARIACEAE.
27. Spores one to multiseptate (in our species), algal cells belonging to Chroolepus. PYRENULACEAE.

PUBESCENCE AND OTHER EXTERNAL PECULIARITIES OF OHIO PLANTS.

EDNA M. MCCLEERY.

In this study of the protective coverings and other peculiarities of the leaves and twigs of Ohio plants, the entire state herbarium has been examined and the plants classified under the following heads:

1. Pubescent—(a) glandular, (b) stellate, (c) tomentose;
2. Glabrous,
3. Glaucous,
4. Granular,
5. Scurfy,
6. Resin dotted, punctate, peltate scales

In some cases it has been difficult to classify certain species on account of many of the forms merging almost imperceptibly from one to another. This is noticeable especially in pubescent and tomentose forms. In other cases the difficulty in classification has come from the change which takes place during development from the young to the mature condition. In Salix candida, for instance, the l[illegible] tomentose when young, but become glabrate [illegible] In Quercus nana the leaves are stellate pubes[illegible] young, but become glabrous when mature, while [illegible] the young twigs are tomentulose but [illegible] glabrous [illegible] all cases of this kind the terms have been [illegible] more heads.

[illegible] number of reported Ohio vas[illegible] 2200. Of [illegible] about 2125 are angiosperm[illegible] and 70 pteridophytes. 904 plants were found t[illegible] This includes all degrees and varities of pubescence [illegible] a soft fine pubescence like the clover and Oxalis [illegible] heavy hairs like the nettles or thistles. For a dense velvety pubescence of both twigs and leaves Althaea off[illegible]alis [illegible] examined; for hirsute pubescence of both twigs [illegible] pias tuberosa is a good example; for soft [illegible]

Phlox pilosa, for appressed pubescent leaves Hydrophyllum virginicum, for ciliate leaves Valeriana sylvatica

Only 37 of the 904 pubescent plants are stellate-pubescent, but these are very striking The butternut, Juglans cinerea, has stellate pubescent leaves, and also four of the oaks, Quercus nana, Quercus marylandica Quercus minor and Quercus prinoides The most pronounced of this type, however, are the two crotons, Croton capitatus and Croton monanthogynus

Of the glandular pubescent forms there are 58 Many plants have stems of this type without having the leaves to correspond About half of the roses as well as Rhexia virginica and Scutellaria cordifolia have glandular hairs on the stems One of the most striking forms in the plant kingdom the Drosera or sun dew, belongs to this group

There are 67 tomentose forms but all of them are not constant throughout their whole life About one half of those which are tomentose when young become either glabrous glabrate or slightly pubescent when mature Many of the oaks among them Quercus platanoides and Quercus minor are densely tomentose on the under side of the leaves The young twig of Quercus minor are also tomentose Viburnum alnifolium is interesting in being one of the few which is stellate tomentose

532 plants were found to be entirely glabrous that is having both sides of the leaves and the twigs entirely free from hairs throughout their whole life but 1019 were found to have one or more glabrous parts The spring beauty Claytonia virginica and wake-robin Trillium grandiflorum are common examples of the former Cercis canadensis and Aster laevis of the latter

Of the glaucous forms there are 59 The glaucous bloom of twigs and leaves is identical with that on some fruit such as plum [illegible] but that on leaves is not usually so noticeable [illegible] on the under side of the leaves of Salix glaucophyl[illegible] [illegible] and on the stems of Vitis bicolor and Hel[illegible] [illegible]ratus

The [illegible] [illegible]ciety forms are compa[illegible] [illegible] [illegible] former and 34 of th[illegible] [illegible] of [illegible] ne armeria and [illegible] [illegible] [illegible] All of the chenopods [illegible] [illegible] those which are resin[illegible] [illegible] There are 1[illegible] in the di[illegible] [illegible] ing group of all Be[illegible] [illegible] minima and or Cham[illegible] [illegible] form on many among [illegible] [illegible] [illegible]tesinosa and Glecoma hederacea [illegible] [illegible] e are the polygonums and the hypericums [illegible]

NEWS AND NOTES.

The sixteenth annual meeting of the Ohio State Academy of Science will be held Nov. 30 and Dec. 1, 1906, at Columbus, Ohio. The meetings will be in the Physics Hall of the Ohio State University. A local committee has been appointed which is taking steps to make this meeting a profitable and enjoyable occasion.

ERRATA. The following corrections should be made in the May, 1906, NATURALIST, page 536: Under *Lophocolea* Dumort., second line, read—underleaves 2-lobed, lobes more or less dentate, *heterophylla* Nees; third line, read—Leaves (all) distinctly bilobed . 2.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, June 4, 1906.

The Club was called to order by the President, Mr. Griggs. The minutes of the previous meeting were read and approved.

Prof. Hine gave a brief talk on "The Mammals of Ohio". He dwelt in particula[illegible] on those species which have been reported as extinct; but which still persist in isolated localities, or wander in from time to time.

Prof. [illegible]ellerman showed a large number of fine views of Guatemala.

Owing to the absence of all the members of the nominating committee, a motion was made and carried to suspend the rules and nominate and elect the editorial board of the OHIO NATURALIST for the ensuing year. The following were proposed and elected:

Editor-in-Chief, John H. Sc[illegible]
Business Manager, Ja[illegible] S[illegible]

Associa[illegible]

Zoology, C. F. Jackson,	[illegible] W. C. Mills
Botany, R. F. Griggs,	Orni[illegible] [illegible]
Geology, C. R. Stauffer.	Geography [illegible] D. [illegible]

The C[illegible] then adjourned for the year.

J. E. HYDE, S[illegible]etary [illegible]

Date of Publication of November Number, November 14, [illegible]

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TABLE OF CONTENTS.

THE NORTH AMERICAN SPECIES OF TABANUS WITH A UNIFORM MIDDORSAL STRIPE.

JAMES S. HINE.

There are a number of species of the genus Tabanus in the Americas characterized by having a regular gray or yellow middorsal stripe continued for the length of the abdomen. Most of them have the anterior leg black with the exception of the base of the tibia which is gray or yellowish; but there are a few variations which will be mentioned later. Such species resemble more or less the very abundant and troublesome costalis and lineola, which are commonly called green-head flies, and which are important stock pests, having been associated in recent years with the transmission of certain infectious diseases of domesticated animals.

There are a score or more of species of this type in North America and several more in South America, but they do not appear to be so numerous in the Eastern Hemisphere. Green-head flies is a common English name for all. Some have a wide range, being reported from northern North America to Brazil and from the Atlantic almost to the Pacific, while others, so far as known, are restricted to much more limited areas.

Wherever I have observed they are the most abundant of their family in season, and are exceptionally persistent in their attacks. They are never particularly conspicuous, nor do they make much noise when flying around an animal, but appear to come from all directions and at once alight on the limbs or under parts, and begin biting before their selected victim is scarcely aware of their presence.

Wooded areas appear to have particular attractions for them. In southern United States, and Central America a

densely wooded tract on rather low and level ground is often referred to as a swamp. Here these flies abound, and at times are so abundant that it is impossible to drive some horses into their domains. Other animals when compelled to withstand their attacks are difficult to control, for the bites are numerous and severe. It is hardly possible to describe their abundance properly, they must be seen to be appreciated fully.

Although the different species are much alike in general appearance, they are quite easily separated when both sexes of all of them are at hand. Some have the eyes hairy, a character which is most conspicuous in the male; in the eyes of some of the males the factes are all nearly of the same size, in others there is a very small area of large factes on the disc of each eye, while in others the area of large facets is so extended that two-thirds of the extent of the eyes is included. Some of the species have the eyes pilose and here the difference in the extent of the area of large factes is as pronounced as in the other case. Where there are no large facets the head is smaller than in the cases where these are .of large extent. Some species have a short stump of a vein near the base of the branch of the third longitudinal, and good specific characters exist in the coloration of the posterior femora. The last two characters seem rather trivial when used in reference to the members of the family in general, but I have found that in this group, when used in connection with the structure of the eyes of the male, they are very constant and consequently may be used with good results in separating the females. The banding of the eyes and the coloration of the thorax and abdomen are specific characters in some cases; also the relative size of the first antennal segment of the various species is of value, but as this last can be expressed only as a comparison with some other species its value in keys and descriptions is very limited.

In some of the species the males have the habit of hovering in the sunshine as the Syrphid flies do. This habit was only observed by myself in two species, both belonging to the section with uniform sized facets. The first observation was made in reference to the species I have identified as Tabanus truquii, near Sanarate, Guatemala. While riding on horseback along the main road I saw the fly hovering about six or eight feet above the ground in bright sunshine. The specimen was accommodating enough to remain in the same place until I dismounted, got my net together and captured it. The other species I observed along the railroad near Puerto Barrios. I had been walking where the track was more or less shaded, but rather suddenly coming out into an open place where the sun's says were not obstructed, I could see dozens of Tabanids hovering just above my head and succeeded in capturing a number of

them. These males with numbers of females from the same locality are types of a species described below under the name Tabanus stenocephalus in refenrence to its very small head when compared with some other species that are much like it in general appearance.

The males of many, perhaps of all the species of Tabanus spend much time flying in the sunshine, but the habit of hovering appears to be confined to a few, may be to those with the small head sand uniform sized facets. Those that do not hover fly so rapidly that the eye cannot follow them, but one is apprised of their presence by recognizing the sound of their wings. Now and then they alight for an instant on some weed or bush, or sometimes on the ground, after which they continue as before.

By including all the species with a uniform middorsal gray band, a few are brought in that are more or less aberrant to the group, consequently at least three treated in the present paper do not appear to be closely associated with the others.

No doubt students will find it difficult to separate out the species falling here, especially if they happen to possess only one or two out of the fifteen or more known.

The following key is offered as an aid, and in every instance does not make use of characters which are considered the most specific, but such as are most likely to be found with the usual limited number of specimens at hand:

1. Posterior femur uniformly reddish for its entire length. 2.
   Posterior femur black or at least blackish on basal part. 8.
2. Wings wide, a distinct brown spot on the furcation of the third vein. **acutus** Bigot
   Wings normal, no brown spot on the furcation of the third vein. 3.
3. A row of rounded gray spots on either side of the middorsal abdominal stripe. 4.
   Three gray or yellow stripes on the dorsum of the abdomen, lateral stripes abbreviated. 5.
4. Costal cell fuscous, a single green band on the eye in life. **fuscicostatus** n. sp.
   Costal cell dilute yellow, two green bands on the eye in life. **sagax** O.S.
5. Eyes pilose, very plainly so in the male. **guatemalanus** n. sp.
   Eyes not pilose. 6.
6. Abdomen reddish, branch of the third vein without an appendage. **carneus** Bellardi
   Abdomen fuscous, branch of the third vein with an appendage. 7.
7. Thorax yellowish. **trilineatus** Latr.
   Thorax fuscous. **appendiculatus** n. sp.
8. Abdomen with a gray middorsal stripe and rounded lateral spots, costal cell fuscous. **fuscicostatus** n. sp.
   Lateral markings of the abdomen not in the form of rounded spots. 9.
9. Abdomen with a middorsal stripe and oblique lateral spots which are angular and contiguous. **lineola** Fabr.
   Lateral markings of the abdomen linear. 10.
10. Thorax dark or nearly black. 11.
    Thorax gray or yellowish. 15.

11. Middorsal stripe clear yellow, wings with some of the longitudinal veins margined with pale brownish. **stenocephalus** n. sp.
    Middorsal stripe gray, wings uniform dilute brownish or hyaline. 12.
12. Wings clear hyaline, eyes pilose. **truquii** Bellardi
    Wings dilute brownish, eyes not pilose. 13.
13. Abdomen dark brown, front of the female unusually narrow. **trivittatus** Fabr.
    Abdomen black, front of the female of normal width. 14.
14. Small species, no lateral stripes on the abdomen. **unistriatus** n. sp.
    Medium sized species, short lateral stripes on the abdomen. **modestus** Wied.
15. Front and thorax gray. 16.
    Front and thorax yellow. 17.
16. Length 9 to 11 millimeters, head of the male very small. **nigrovittatus** Macquart
    Length 12 to 14 millimeters, head of the male large. **conterminus** Walker
17. Eyes with a single green band in life, costal cell distinctly colored. **costalis** Wied.
    Eyes with two green bands in life, costal cell nearly hyaline. **quinquevittatus** Wied.

Tabanus acutus Bigot. General color, light brown; first two segments of the antenna and the base of the third light brown, apex of the third darker; wings wide, light brown and with a small dark spot at the furcation of the third vein; legs concolorous with the body, apex of each anterior tibia and all the tarsi darker; abdomen light brown, a little darker toward the apex, with a middorsal, wide, gray stripe extending for the whole length.

Female: Length 15-19 mm., head rather small, face and front clothed with yellowish pollen, front of normal width, sides parallel, frontal callosity large, shining chestnut in color, inferiorly not quite as wide as the front, narrowed slightly above and with a connected line extending more than half way to the vertex, abdomen elongate, conical, gradually narrowed toward the apex.

Male: Length 14–16 mm., head rather small, hemispherical; abdomen quite noticeably narrowed to two thirds of its length, sides nearly parallel from thence to apex.

Habitat: Several males and females taken along the Mississippi River below New Orleans, also one female from Cameron near the Gulf Biologic Station.

It seems certain that the identification is correct in this case, for the species is such a striking one that a short description is sufficient to fully characterize it. Bigot placed it in the subgenus Atylotus but it does not belong there.

Tabanus appendiculatus n. sp. General color fuscous; first segment of the antenna large, clothed with short black hairs above, entire antenna reddish with the exception of the annulate portion of the third segment which is darker, wing hyaline with a

rather conspicuous brown stigma and brownish margins to some of the longitudinal veins near the apex; fork of the third vein with a short appendage; posterior femora wholly red; abdomen fuscous with three stripes yellowish-white in color, the lateral ones not usually reaching beyond the third segment.

Female: Length 10–14 mm., head wider than the thorax; front slightly narrowed below, clothed with yellow pollen, callosity shining nearly black, slightly narrower than the front, nearly square with a very narrow, sometimes unconnected, line above; face clothed with white pubescense; thorax dark, in well preserved specimens with more or less greenish reflecting pollen and scattering, short, black hairs.

Male: Leagth 14 mm., head decidedly broader than the thorax with a large area of very large facets; face and breast clothed with white pubescense; disc of the thorax with rather dense erect, nearly black hairs which are much longer than in the other sex.

The types of the species were taken at Puerto Barrios, Guatemala, March 4, 1906, numerous other specimens from Gualan and Panzos in Guatemala, Belize in British Honduras and Puerto Cortez in Spanish Honduras.

Tabanus carneus Bellardi. General color reddish; antenna red with the annulate portion of the third segment slightly darker; wing hyaline, stigma brown, fork of the third vein without an appendage; posterior femur entirely red; abdomen red, a little darkened at the extreme apex, three yellowish-white dorsal stripes, the middle one plainly marked for the whole length, but the lateral ones almost obsolete.

Female: Length 11–13 mm., thorax above reddish, sparsely clothed with gray pollen and short dark hairs.

Male: Length 13 mm., head wider than the thorax, with a distinct area of enlarged facets on each eye; thorax above reddish, rather densely clothed with erect brown pile and a small amount of gray pollen.

Habitat: Specimens are at hand from Frontera, Mexico and from Puerto Barrios, Guatemala.

Tabanus conterminus Walker. Before describing this species it is well, perhaps, to offer an explanation for using this name. When the males of the species of the Atlantic coast are brought together it is certain that there are two species in what has gone under the name of T. nigrovittatus ever since Osten Sacken published his Prodrome of a Monograph of the Tabanidae of the Eastern United States. Having the males separated I studied to locate their females and believe I have succeeded. Walker's description appears to fit the species very well for color and exactly for size, so the name is adopted until it can be proven just what the proper solution of the matter is.

The species is colored much like nigrovittatus as given below. However, the thorax is a steel gray while in the last named species this part is gray but very slightly tinted with yellowish. Specimens are rather narrow and elongate and the length appears to be of specific value, at least such is the case with the specimens at hand. The males of the two species are very different: in conterminus the head is very large, as in costalis, and the area of enlarged facets extends back to the occiput above, while in nigrovittatus the head is small with the area of enlarged facets confined to the disc, a band of small facets occupying the upper part of the head forward as far ar one-fourth the length of the line of union of the eyes. Length of both sexes 12-14 mm.

Habitat: Specimens are at hand from Beaufort, N. C., collected by Sherman; Avalon and Cape May, N. J., and Fernandina, Florida.

Tabanus costalis Wiedemann. This species is well known over a large part of North America. The thorax is decidedly yellow, the wings are hyaline with the costal cell yellowish-brown and the abdomen varies some in coloration, but the mid-dorsal band is always present, regular and yellow in color; in living specimens the eyes are crossed by a single green band. Length, 11-15 mm.

Tabanus fuscicostatus n. sp. General color fuscous; front of normal width, yellowish-gray in color, sides nearly parallel, frontal callosity brown nearly square and with a line, usually unconnected above, antenna rather long, basal segment slender, third segment with a well defined basal process above and with the annulate portion black or at least dark, palpi white, proboscis black; face, sides and ventral part of the thorax clothed with white pollen and pile; disc of the thorax gray, unstriped; legs reddish in general coloration, all the femora often cinereus on basal part, apical part of each anterior tibia and all the tarsi brownish; wing hyaline with the costal cell dark, fuscous in most specimens; abdomen with a distinct middorsal stripe which has a tendency to increase slightly in width at the posterior border of each segment, and a row of spots on each side. Length of the female 10-15 mm.

Type locality Baton Rouge, Louisiana, but specimens are at hand from various parts of that state. From dry specimens the species can easily be placed under sagax for the color of legs and abdomen are right for that, but when the living specimens are studied it is found that the eye is crossed by only a single green band which, with the colored costal cell, would denote realtionship with costalis. The male was not procured.

Tabanus guatemalanus n. sp. Head very large, eyes pilose; general color dark brown, some specimens approaching reddish; antenna red with the annulated portion of the third segment

black, first segment a little larger than the same in costalis, third segment not especially wide, a well defined basal prominence, annulate portion about the same length as the basal; legs mostly reddish; anterior femur on the upper side, anterior tibia at apex and all the tarsi dark; wing hyaline with a small brown stigma; abdomen brown, in some specimens notably darker than in others, with three yellow, middorsal stripe reaching the apex, the lateral ones abbreviated behind.

Female: Length 12–15 mm., front rather wide, slightly narrowed below, clothed with yellowish-brown pollen and a few hairs; callosity pale brown, nearly square with a very slender connected line above; thorax above rather dark, clothed with gray pollen and dark hair, face and sides of thorax with white hair.

Male: Length 12-15 mm., head with an extensive area of large facets, small facets behind the large ones compose a band entirely behind the point where the eyes unite at vertex; thorax a little lighter than in the feamle and clothed with longer hair.

The eyes in this species are plainly pilose in the female as well as in the male and by this it may be known from others. The very pale frontal callosity in the female is also distinctive. Many specimens taken at San Jose, Guatemala, February 5, 1905. They were taken by beating a large grass that grew only a few yards back from the beech.

Tabanus lineola Fabricius. This common species is known from all the others mentioned in this paper by the oblique, angular and connected row of spots on each side of the abdomen. It is the only one of these species that has any suggestion of stripes on the thorax. Length about 14 mm.

Tabanus modestus Wiedemann. Length 13–15 mm., general color black; antenna red, first segment enlarged with black hairs above, third segment with a prominent basal process, annulate portion darker in color than the basal; front of normal width, slightly narrowed below, clothed with yellow pollen, callosity shining black narrower than the front and with a connected line above; thorax above grayish-black; wing uniformly dilute brownish with a darker stigma; legs black except the base of each anterior tibia which is white, and all the other tibiae which are reddish except extreme apexes; abdomen with a middorsal narrow white stripe, and a more or less obscured stripe of the same color on each side only reaching the third segment.

Specimens are at hand from San Carlos, Costa Rica. The size in conjunction with the color of wings and body serve to distinguish this from other species here mentioned.

Tabanus nigrovittatus Macquart. General color similar to costalis; antenna reddish, first segment slender; third segment with an angle above, annulate portion black, slightly longer

than the basal; thorax gray above with a faint yellowish tinge; abdomen black in ground color, except each side of the first three segments which is red, a gray middorsal stripe and on the last three or four segments indications of gray lateral stripes; wings hyaline with the costal cell dilute yellowish; extreme apexes of all the femora, basal part of anterior tibia and all except the extreme apexes of the other tibiae yellow, otherwise legs dark brown or black.

Female: Length 9–11 mm., front clothed with gray pollen, sides parallel, callosity nearly square, shining and with a line above.

Male: Length 11 mm., head small with only a few large facets on the disc of each eye. For further statements regarding the male of this species see under conterminus above.

Habitat: I procured a number of this species at Bay Ridge, Maryland, by sweeping in grassy areas near water. Others from Durham, N. H.; Suffield, Ct.; Woods Hole, Mass.; and Anglesia, New Jersey.

Tabanus quinquevittatus Wiedemann. General color much as in costalis. Head large; first segment of the antenna somewhat enlarged and furnished with short black hairs above, third segment rather wide, basal portion red and with a well defined angle above, annulate portion about as long as the basal; thorax yellowsih-gray; wing hyaline with a small yellow stigma; front legs black with the exception of the basal parts of the tibiae which are yellow, apexes of femora of the other legs, tibiae and metatarsi of the middle legs, and tibiae except apexes, and the metatarsi of the posterior legs yellow, other parts brown.

Female. Length 13–16 mm., front of normal width, slightly narrowed below, callosity shining black and nearly square; abdomen above with the margin on each side and three stripes yellow, intervals between the yellow dark brown or black.

Male: Length as in the other sex, head very large, area of enlarged facets extensive, a narrow band of small facets next the occiput above; abdomen somewhat variable: the middorsal stripe well marked and margined with fuscous on either side, remainder usually pale yellowish without well defined markings.

Habitat: Gulf coast of Louisiana, and Galveston, Texas. Bellardi has it from Mexico.

Tabanus sagax Osten Sacken. This appears to be the least common of the species here treated. The legs are red throughout with the feet slightly darker than the other parts; the thorax is dark, thinly clothed with grayish pollen; abdomen with a distinct middorsal gray stripe and a row of spots on each side, a pair to each segment; wings hyaline, costal cell dilute yellowish. Length 13–16 mm. Known from Illinois, Minnesota and New Jersey.

Tabanus stenocephalus n. sp. General color dark brown, nearly black; head rather small, antenna red with the annulate portion of the third segment black, first segment enlarged and clothed with black hairs above, third segment with a well defined angle above at base, annulate portion shorter than the basal; thorax dark brown above, wings faintly clouded, stigma prominent, brown, longitudinal veins near the apex faintly margined with brown, branch of the third vein without an appendage; anterior leg black except the basal part of the tibia which is white, other legs with basal half of each femur, extreme apex of each tibia and each tarsus black, other parts yellowish; dorsum of the abdomen very dark brown, a middorsal stripe and an abbreviated lateral stripe on each side clear yellow.

Female: Length 12–15 mm., front of medium width, narrower than in costalis, yellow pollinose, callosity rather small and shining black.

Male: Length as in the other sex; head of nearly the same form and size as in the female, facets of the eye all small, nearly of the same size; abdomen gradually narrowed from the base. This sex was taken while hovering in the sún about the middle of the forenoon.

Habitat: Specimens were taken at Puerto Barrios, Morales, and Panzos, all in Guatemala, during the first half of March.

In appearance much like appendiculatus, but the head of the male, the dark middle and posterior femora and the simple branch of the third vein are distinctive. Much darker in coloration than costalis.

Tabanus trilineatus Latreille. Bellardi, in his Diptera of Mexico, included a species which he called trilineatus but Osten Sacken who saw his specimen says that it is a synonym of lineola. The specimens I have placed under trilineatus are mostly from British Guyana, but one or two are from San Carlos, Costa Rica. They are lighter in coloration than specimens of appendiculatus, in fact nearer to costalis in this particular. The front is of normal width, the thorax is decidedly yellowish, the wings are hyaline with a rather pale stigma, and the fork of the third vein bears an appendage; the middorsal abdominal stripe is quite wide and the lateral stripes reach the fourth or fifth segment. All these stripes are decidedly yellowish in coloration. The eye of the male has a distinct area of enlarged facets which is separated from the occiput above by a narrow band of small facets.

Tabanus trivittatus Fabricius. The species I have placed under this name appears to agree well with Wiedemann's description of what I suppose were the types that Fabricius described. The most characteristic points in regard to the species are the very narrow front and the very dilute brownish wings. Other-

wise it looks much like a small specimen of lineola. The first segment of the antenna is enlarged and clothed with black hairs above, the third segment is red with the annulate portion black, basal portion rather wide with a prominent angle above; all the femora and tarsi black, anterior tibia at base and the other tibiae in their entirety yellow; thorax dark; abdomen very dark brown, middorsal stripe entire, white and narrow, lateral stripes yellowish, reaching the third segment.

Specimens from San Carlos, Costa Rica, measure 13 mm. in length.

Tabanus truquii Bellardi. General color dark, something like the darker specimens of lineola, female abdomen darker than that of the male. Eyes pilose, although this character in the female is not conspicuous; first segment of the antenna much enlarged, dark red with black hairs above, basal portion of the third segment dark red, a well developed angle above, annulate portion brown; thorax dark, sparsely clothed with gray pollen, wing hyaline with a narrow dark brown stigma, front leg except basal part of tibia, middle femur at base and tarsus, posterior femur at base and apex of tibia and entire tarsus, black, otherwise legs red.

Female: Length 16 mm., front with sides parallel, clothed with brownish-yellow pollen; abdomen dark with three white stripes, middle one entire, lateral ones reaching the third segment.

Male: Length 15 mm., head of normal size, convex; eyes decidedly pilose, facets all nearly of the same size; abdomen not so dark colored as in the other sex, middorsal stripe narrow, lateral stripes not plainly defined.

Specimens from Sanarate and Panzos, Guatemala, taken in February and March.

Tabanus unistriatus n. sp. This species is a miniature of modestus in general appearance but the front is much narrower in proportion and there are no lateral stripes on the abdomen. Antenna red, first segment enlarged, third segment with an angle above and with its annulate portion black and not over half as long as the basal portion; front narrow, decidedly narrower below than above, callosity elongate, shining; thorax black, sparsely clothed with greenish-yellow pollen, wings uniform dilute brownish, legs with all the femora and trasi and the apical half of the anterior tibiae black, other parts red; abdomen black above with a narrow middorsal white stripe reaching the end of the sixth segment.

Length of the female 7–9 mm. The male was not procured.

Habitat: Specimens from San Carlos, Costa Rica, are the property of the U. S. National Museum.

TWO NEW SPECIES OF DIPTERA BELONGING TO ASILINAE.

JAMES S. HINE.

Up to the present time only a single species has been placed under each of the genera Machimus and Stilpnogaster. It is possible that others properly belonging here have been described under the genus Asilus where all the old authors placed nearly all their species of the subfamily. This latter genus has not been revised for North America, but all descriptions are accessible, and the two species considered here appear to be distinct from others previously recognized, so are taken to be new. One species belongs to each genus mentioned.

Machimus griseus n. sp. Male and female brownish gray with reddish legs and narrow white annulations at the apexes of the abdominal segments. Wings hyaline with well defined dark markings at the apex and posterior border.

Front and face of usual width, gibbosity of the face prominent extending two-thirds of the distance from the oral margin to the antennae; mystax with black bristles above and white ones below; antennae black, rather long, third segment with its style decidedly longer than the other two segments combined, style equal in length to the other part of the segment; beard white. Thorax dark in ground color but clothed with gray pollen which is denser in some places than in others, thus giving the part a variegated appearance; a wide middorsal black stripe divided anteriorly by a narrow grayish interval; scutellum with two black bristles at the apex; legs red with numerous black bristles, coxae black, all the femora darkened before, except just before the apex of each; wing clear hyaline with dark markings as follows: marginal, submarginal and first posterior cells, each with a stripe which reaches the apex of its respective cell; other posterior, discal and anal cells each with an angular spot not contiguous with the margin of the wing; halteres very pale in color. Abdomen of the same general color as the thorax, with a light colored annulation preceded by a row of nearly white bristles at the apex of each segment. Eighth segment of the male distinctly produced below, but not appendaged as in some of the European species of the genus; male genitalia reddish in color, oviduct shining black. Length of male and female, 17–20 mm.

Habitat: Several specimens from Southwestern Colorado.

The female is larger than the male in the specimens before me. The water clear wings with the well defined markings as described are sufficient to distinguish the species from its near relatives.

Stilpnogaster auriannulatus n. sp. General color shining blue-black with uniform pale brown wings and black and yellow legs.

The second, third and fourth segments of the abdomen each with a golden yellow annulus at its apex.

Front and face rather narrow, the latter covered with golden yellow pollen between the callosity and the antennae, callosity slightly elevated, mystax black, beard white, third segment of the antenna about as long as the other two together, style shorter than the remainder of the segment; thorax dark in ground color, clothed with pollen which is denser in some places than in others, middorsal stripe opaque black, narrowly divided on the anterior part; scutellum with several black bristles at its apex; wing uniformly pale brown all over with a slight intensity of coloration on the margin of the second vein near the middle of its length. Legs black and yellow, a preapical ring on each femur, all the tibiae except at apexes and bases of the tarsal segments yellow, other parts black; hind femora somewhat variable in that the yellow is likely to increase at the expense of the black; halteres yellow. Abdomen shining blue-black, second, third and fourth segments each with a golden yellow annulus at apex not preceded by a row of bristles; eighth segment below not widened but furnished with a conspicuous tuft of erect hair. Genitalia of both sexes shining black, of the male somewhat wider than the abdomen when viewed from above and about as long as the seventh and eighth segments combined. Length 14–17 mm.

Several specimens of both sexes taken in the Hope Mountains of British Columbia by R. V. Harvey and R. S. Sherman of Vancouver, during the first part of July.

A SUCCESSFUL MUTANT OF VERBENA WITHOUT EXTERNAL ISOLATION.*

JOHN H. SCHAFFNER.

While botanizing in Clay County, Kansas, during the past summer, I discovered a peculiar type of *Verbena stricta* Vent. The color of the flower in this species, in Kansas, is quite uniformly a deep purplish-blue. One may occasionally find a slight variation in shade in isolated individuals. But these fluctuating variations are insignificant both in number and degree. The peculiar form which I discovered was very different from the type and its variants. The color of the corolla was a pinkish-white and the individuals, numbering several thousands, were found to be remarkable for the uniformity of this character. There were no transition forms whatever. The mutant had a much smaller color variability than the parent species, and no other peculiarity. than the color of the corolla was discovered.

The mutants covered about a square mile of territory. In some directions, however, they have advanced for nearly a mile beyond what seems to have been the center of distribution. An isolated specimen was found two miles northeast of this center. A knowledge of the exact position of these mutants may be of some importance in the future. They are found, for the most part, on Section 26 of Town 7 South, Range 1 East, Clay Co., Kansas, and bloom the last week in July and the first in August. The whole central part of the section is rough land and has never been cultivated. It contains creek bottom land, ravines, hillsides, and high prairie. The soil is very diverse, containing most of the soil types present in the region. The mutant was found indifferently on nearly all kinds of soil and habitat which the section afforded. In some places the normal type was more abundant, in others the mutant, while in still other spots both were present in about equal numbers, growing together closely intermingled.

We have here, then, a sharply defined color variety which raises many interesting and disputed questions. The new form is clearly a mutant differing from the parent stock in a single distinct character. It originated in its native environment under normal conditions. The new color arose suddenly from one or more normal parents instead of through the cumulative effect of selection by insects of minute fluctuating variations. In fact the whole hypothesis of the origin of distinct colors in flowers by selection through the agency of insects, or otherwise, falls to the ground so far as this case is concerned. The old form has not been affected by the origin of the new either through variation or cross fertilization. Now de Vries says that "we

* Read at the meeting of the Ohio State Acad. of Science, Nov. 30, 1906.
Contributions from the Botanical Laboratory of the Ohio State University, XXVII.

must conclude that new species are produced sideways by other forms, and that this change affects only the produced and not the producer". The Verbena mutant is an example exactly to the point. But in using the term "mutant," I do not wish to be understood as necessarily accepting de Vries' notions of the hereditary apparatus wihch produces mutants.

The color of this mutant is probably a unit character with Mendelian dominance or recessiveness and for this reason the new race remains pure though growing together with the old. If the character is not Mendelian there must be some physiological peculiarity which prevents cross-fertilization as cross-pollination must certainly take place. Many generations must have preceded the present progeny and a considerable number of years must have passed since the origin of the first mutant.

This mutant is not of hybrid origin. Hybrids between certain species of Verbena are common but are easily recognized from morphological characters. No hybrids were found in the locality. A careful search was made in all directions from the mutant section but no other individuals were found except the one individual noted above. This could easily have been transported from the original locality. Whether the same mutation has occurred at other times or in other localities, I have at present no means of knowing. But it is not unlikely that it has appeared in other places also.

Some have claimed that mutations have been observed mostly among domestic forms. This is true, because these are far more accessible for ordinary observation than wild species. But with proper investigation mutants may turn out to be as abundant in the field as in the garden. One must live in the field and be thoroughly familiar with the plants of the locality before he is likely to notice even the more striking mutations, should he be so fortunate as to pass by their isolated habitat.

DeVries' Oenothera lamarckiana was introduced into Europe from America. The species had thus undergone a great change of environment and objections have been made to some conclusions based on the mutants of this species, yet it seems to me without reason. I have myself observed types of Oenothera biennis in Kansas which agreed with no descriptions given in the manuals. Moreover, the question as to what conditions are favorable to or cause mutation is not directly involved in the question of the fact of mutation. We have in nature most of the peculiarities of environment which we can produce artificially and primarily it makes no difference as to the fact of evolution by mutation whether the elementary species arises on a virgin prairie from an indigenous species like the Verbena stricta mutant, or from an exotic plant cultivated in a highly artificial garden. Many of the most important principles and

processes of evolution can be discovered only through series of pedigree cultures. The peculiar notion, that species, to be good species, must have their origin in the field, or nature's garden, and not in man's, has come down to us from a previous generation. This notion with other modes of thought, formulae, and assumptions has been so diffused through scientific thought and literature that it is held by many as a kind of dogma which if logically applied would exclude experimentation entirely as a factor in determining the character of evolution and speciation.

Any mutation which is Mendelian may theoretically give rise to a new race under favorable conditions. At the present time one may sometimes find two or three species according to the systematist among the branches of a single tree. There is, therefore, no occasion to waste words as to what is a true species or elementary species, nor how great or small a variation must be before it may be called a mutation. The real test should be as to whether the type breeds true without special selection or isolation. Recently the claim has been made by certain natural selectionists that it is selection and segregation that makes mutants breed true. But deVries' mutants and the Verbena mutant have, so far as anything can be determined by field observation, the quality of breeding true, created by or along with the original mutation process and not by selection. Perhaps if I were able to study and test some of the qualities of the Verbena mutant by means of definite pedigree cultures, the claim would again be made that the method employed was a process of selection. Although the Verbena mutant is a decided saltation, there is no reason why a similar change should not take place in a given locality by a series of very small advances, the saltation so to speak, continuing through a number of generations before again coming to a more or less fixed type. But this is outside of the questions raised by the case in hand.

The opinion has been commonly held for many years that sports, in the old sense of the term, are lost by the swamping effect of cross-breeding. But if there are variations which are not swamped, selection becomes an unnecessary factor in the origin of distinct forms; and the Verbena mutant is a case in evidence of a distinct type entirely successful from the beginning. This belief that sports are always swamped is, however, largely based on assumption.

Geographical isolation has, recently, also been claimed to be the important factor in speciation. The statement that no two closely related species or subspecies occupy the same territory or even the same habitat certainly appears ill-founded to anyone acquainted with the distribution of plants In many cases, according to Britton's Manual, the variety has the range of the type and this is true for species where the habitat is of a uniform

character. Other varieties appear to be localized either in the center of the distributional area or at one side of it although still within the limits occupied by the type. Geographical botany in America is still in its infancy. and it is a question whether much weight is to be attached to present statements in regard to distribution; but there is no more certainty as to the data concerning subspecies localized in geographically distinct areas, whether isolated by physiographic or climatic barriers. In the Verbena mutant we have not only a distinct type which originated by a saltation in a definite direction but a type which spread side by side in the same habitat with the parent and kept itself distinct without the aid of external selection or isolation of any kind. The isolation in this case is resident in the internal nature of the plant and had its origin in the same physiological and hereditary processes which gave rise to the original mutant.

It is assumed by many that, in case a new species arises with a character or quality more advantageous than the old, the new will finally displace the old through the struggle for existence. This is a hypothetical assumption which often appears to be without foundation in fact. If conditions of habitat were uniform and if each species lived in only one type of habitat and could endure only one narrow set of conditions there would be grounds for the general assumption. But most species can live in quite diverse habitats and under quite diverse and varying degrees of favorable and unfavorable conditions. There is a great difference in the character of plants adapted to similar habitats and still on a natural prairie conditions settle down to a sort of equilibrium with a complex flora where one species or at most a few ought to hold complete sway. The physiography, the habitat, the soil, and the plants are always shifting, always changing; and in this constant shifting and changing room is made not only for the stronger but also for the weaker. Burrowing animals, rain, wind, and gravity, are ever at work. It is not always necessary for the new type to migrate to a separate geographical area in order to survive unless its nature has been changed to such a degree as to put it out of all harmony with its surroundings. The two forms may divide the diverse and varying habitats of the region between themselves and exist side by side for an indefinite period just as the parent stock before division shared the habitat with others. Or one might say that the wild species may continue to exist in a continually changing physiography for much the same reason as cultivated plants continue to exist in man's cultivated field. And finally, is it not immaterial whether a species, to be a good species, cover a square mile or a continent, whether it continue for ten generations with a few thousand individuals or for a geological period with countless millions?

DESCRIPTIONS OF NEW MALLOPHAGA, II.

E. P. DURRANT.

4. **Physostomum merulae nov.** sp. (Fig. 1, D.)

Female: Body, length 4.7 mm., width 1.3 mm.; light fulvous, of rather uniform color except abdomen, which has the lateral bands distinctly marked: of large size and evenly rounded outline.

Head, length .75 mm., width .75 mm.; front broad and evenly rounded, margins diverging somewhat and slightly swelling, ocular notch medium, fleck distinct, notch with one small hair; temple extended posteriorly, slightly obtuse, three large bristles along margin evenly spaced, anterior two with one small hair between; occipital margin deeply re-entering; labral lobes large; antennal fossae well-marked by brown bands on lateral borders, interior band much broader; palpi extending beyond margins; anterior submargin with four long, and numerous short hairs.

Thorax, length 1.20 mm., width 1.04 mm.; prothorax broader than long, a little narrower than head, anterior convex, posterior concave, margins nearly straight except at anterior, which has a rounded notch; the anterior angle has two small hairs and a bristle; the rounded posterior angle has one bristle; marginal extensions of even width and clear.

Metathorax larger than prothorax, rounded in front and widely diverging to rear, posterior margin slightly concave; two small bristles at posterior angle; lateral margins with wide light-brown band; lighter and narrower bands diverging from posterior of prothorax to posterior two-thirds of metathorax and uniting with marginal bands; legs same color as head and thorax, of medium size.

Abdomen rounded oblong, first seven segments of nearly equal length; the transverse sutures straight; first four segments have a hair and a long bristle at angles, the next have two bristles and the eighth two long bristles on posterior border with a fringe of fine short hairs between; lateral line terminating abruptly on median border, but continued to lateral borders by a lighter shade, no lateral line on last segment.

Description from specimen in Professor Osborn's collection, taken from Merula migratoria propinqua at Ft. Collins, Col., by C. F. Baker.

This species bears a close resemblance to P. mystax Nitzsch, but is distinguished by larger palettes and the shallower and more anteriorly placed notch of the prothoracic extensions.

5. **Physostomum cherriei** sp. nov.

Female (Fig. 1, E.). Length 3.4 mm., width .9 mm.; except the pitchy brown sub-marginal lateral bands on abdomen and similarly colored blotches on head and thorax, it is of very uniform pale-brown.

Head, length .78 mm., width .62 mm.; evenly rounded in front and rather broad, widening toward posterior, the lateral margins nearly straight; ocular notch small with three small hairs, fleck wanting; temple clear, with two small hairs and two large bristles alternating, posterior angle just perceptibly out-turned; occipital margin broadly concave with narrow sub-marginal band; palettes of medium size, light-brown backward-curved band behind; two curved, brown blotches between antennal fossae and labral lobes; antennal fossae with narrow dark-brown curving line near minor border; palpi not extending beyond margin of head; clypeal suture marked by pale band.

Thorax, length .88 mm., width .73 mm.; prothorax broader than long and narrower than head; anterior and posterior margins concave, lateral and posterior angles rounded, the former with a short and a medium length bristle, the latter with one long bristle; a short thick bristle nearly opposite temporal angle; dark-brown bands extend from anterior to posterior part, being marginal half the distance back, the rest of the way submarginal; a narrower and paler band on each side of the median line extends nearly full length of prothorax with slight outward curve; narrow dark bands in posterior half extend obliquely backward toward median line; marginal extensions pale brown.

Metathorax longer and wider than prothorax, anterior part covered by it; width a little less than length; anterior margin rounded then incurved at middle of lateral margin, which then diverges to posterior angle; posterior angle with one short and one long bristle; anterior rounded margin with three small bristles; dark-brown marginal bands extend along anterior border halfway back then curve in, cross the straight sub-marginal bands running whole length of metathorax, and then curve forward to a point two-thirds from posterior margin. Legs of pale-golden color.

Abdomen, with sides only slightly swelling widest at middle, last segment evenly rounded, with border of genital opening slightly extending; segments of nearly equal length and transverse sutures straight except last three which are posteriorly convex; posterior angles have long bristles, last segment with two shorter bristles on each side half way from median line, genital extension with fringe of fine hairs; lateral line dark-brown with band of lighter brown extending to margin of body

and broken obliquely at sutures, band in last segment half the length of the segment; central part of segments clear light-brown.

Male (Fig, 1, F.). Length 3.07 mm., width .81 mm. General form very close to that of female, markings of head, thorax, and body a little darker, lateral bands not extending into eighth segment.

Described from seven specimens in Professor Herbert Osborn's collection, taken by George H. Cherrie from Melozone cabanisi and Melozone leucotis, four females from the former and two males and one female from the latter.

This species shows considerable resemblance to P. subangulatum Carriker and to P. subhastatum sp. nov. in general form but differences in size and in arrangement and form of markings and various details of shape seem to require the establishment of a new species.

This work was carried out in the Zoological Laboratory of Ohio State University under the direction of Professor Herbert Osborn, to whom the writer is greatly indebted for valuable assistance.

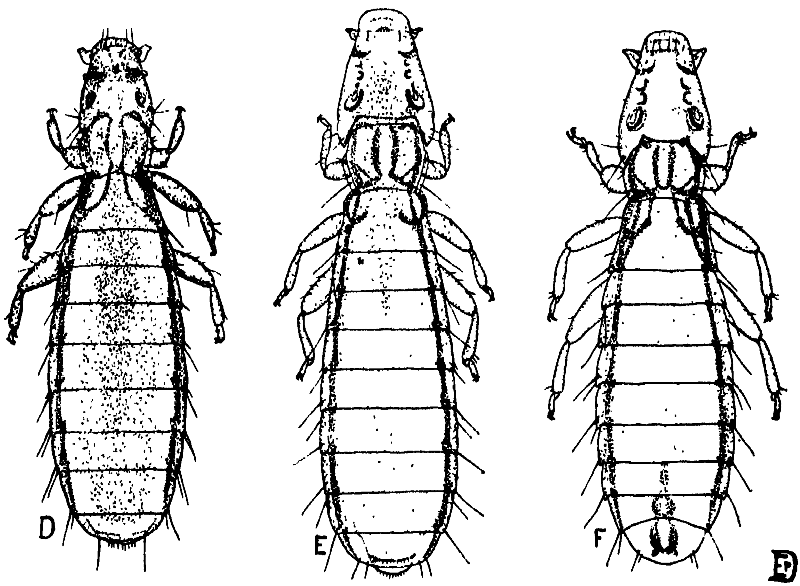

Fig. 1. D. Physostomum merulae, from Merula migratoria propinqua. x 15. E. Physostomum cherriei, from Melozone sp. x 20. F. Physostomum cherriei, male, from Melozone sp. x 24.

NOTE ON HABITS OF SENOTAINIA RUBRIVENTRIS MACQ.*

HERBERT OSBORN.

This species of tachinid has been observed on several different occasions at Cedar Point, and its habits are of such interest that the record of some of these observations may be in place. In the vicinity of the laboratory certain pompilid wasps are quite common and may very frequently be seen dragging spiders with which to provision their nests. On several occasions during the summers of 1905 and 1906, I have observed these tachinid flies following the wasp as it drags its burden along the sand. The flies may vary in number from two to as many as nine, the highest number noticed, and in following the wasps hover at a very constant distance, about six or seven inches, progressing and halting almost mechanically with the movement of the spider. If the spider is dropped, the flies remain stationary, hovering an inch or two above the surface of the sand or, if the spider is left for some minutes, they may rest upon the sand, but always with the head directed toward the spider, and apparently with the attention concentrated fixedly upon it. So intent are they upon this object that they may be pushed about with a stick or otherwise interfered with, with scarcely any diversion from their intentness. Immediately upon the return of the wasp and movement of the spider ,they are on the wing and maintaining the constant distance noted. The wasp appears to pay but little attention to them, although if approached too closely, it may show some slight indication of annoyance and the flies appear to be on the alert for any offensive action on the part of the wasp.

On one occasion I had the opportunity to see the actual entrance of the flies into the burrow. The flies hovered at about the usual distance from the spider while it was resting at the mouth of the burrow, but appeared unusually excited, making quick movements sidewise in maintaining attention upon the spider and when finally the spider was dragged into the burrow a very quick movement was made and some of the flies were seen to actually pass down in the burrow but apparently only one or two succeeded in entering and remaining; perhaps the one first getting opportunity to enter being recognized as the rightful inhabitant. Clearly the entrance of the burrow was for the purpose of depositing eggs and we cannot doubt that the species is parasitic within the nest of this pompilid. A related species, Senotainia trilineata, is recorded as being reared from the nest of *Sphecius speciosa*. The species was kindly determined for me by Prof. J. S. Hine.

*Read at the meeting of the Ohio State Acad. of Science.

NODDING OF THE TERMINAL HEADS OF SILPHIUM LACINIATUM.

JOHN H. SCHAFFNER.

During the past summer, while botanizing in Kansas, my attention was attracted to a peculiar eastward tipping of the terminal heads of *Silphium laciniatum* L. I had noticed such a phenomenon before in the common sunflower, in which the terminal heads, especially of small plants ,normally tip to the northeast.

In the compass plant, anthesis begins in the terminal heads and a strong eastward nodding was observed to be almost universal in these although the lateral heads appear to have the property to only a slight extent. On July 7th and 8th, a large number of plants was observed in an open prairie lot near Mayetta. The wind was from the east-southeast at the time and it is difficult to see how it could have had anything to do with the phenomenon. Of 135 plants in bloom at the time, the terminal heads of 123 faced in an easterly direction and 12 in other directions. But of these 12, several had imperfect peduncles. So the percentage of indifferent normal heads was very small.

The compass plant often grows in clusters of half a dozen or more. Frequently the terminal heads of all the plants in a group are in bloom at the same time and are tipping to the east. In such cases the appearance becomes striking when contemplated in connection with the north and south direction commonly taken by the basal leaves.

Later other observations were made at various places as opportunity afforded and always a very large percentage of the terminal heads were found nodding towards the east.

In the common sunflower, the exposure of the large green involucre in the most favorable position with respect to the rays of light must be a decided advantage to the plant. But in Silphium laciniatum the involucre is rather insignificant and appears to be of little importance as a photosynthetic organ.

MEETING OF THE BIOLOGICAL CLUB.

BOTANICAL HALL, October 2, 1906.

The Club was called to order by the President, Mr. Griggs. The minutes of the previous meeting were read and approved.

The program of the evening consisted of reports of the summer's work by the members. Prof. Osborn reported on the work carried on at the Lake Laboratory. Especially the work of Prof. Rice on the bird fauna of the Point, and Prof. Walton on the Protozoa and Annelids. Prof. Schaffner spent his summer in Kansas working on the flora of that region. While at work there he noticed a case of mutation in Verbena stricta. The normal flowers of this Verbena are colored a purplish blue; but the mutants were a whitish pink, and were found covering an area of about one square mile, being mixed with the native blue form. Prof. Hine spent the greater part of the summer at the Gulf Biologic Station in the interest of the Crop Pest Commission. He reported that as yet no remedy had been discovered for the Cotton Boll Weevil, as a result it is spreading rapidly eastward and northward; and at last reports was within thirty miles of the Mississippi River. Prof. Ball reported that the Codling Moth and the Grasshopper cause a million dollars worth of damage annually in Utah. A Leaf Hopper that works on the sugar beet caused an estimated damage of seven hundred and fifty thousand dollars last year, while this year it caused practically no damage at all. Prof. Griggs reported on the fruiting habits of Bidens beckii, which he observed at Cedar Point. Bidens beckii which is an aquatic develops a seed provided with five barbed spines which are about an inch long.

Prof. Osborn, Prof. Hine and Prof. Schaffner were appointed on a committee to nominate officers for the ensuing year.

Prof. Osborn, Prof. Landacre and Mr. Metcalf were appointed on a committee to formulate a plan for entertaining the Ohio Academy of Science at its Thanksgiving Meeting in Columbus.

Z. P. METCALF, Secretary.

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SYNAPSIS AND SYNIZESIS *

JOHN H. SCHAFFNER.

The term, synapsis, has, in recent years, gained wide currency among cytologists as a designation for various real and hypothetical processes supposed to take place in the early stages of the reduction division. At the present time cytological literature abounds with contradictory accounts of various cell activities supposed to be normal, until one is not only amused but utterly confused. In order to give the word, "synapsis", a more definite meaning, McClung† has proposed the following definitions which it might be well for plant cytologists to consider. "By synapsis I mean the fusion of simple chromosomes into multiple ones, usually of a bivalent value, according to the idea of Moore, who proposed the term. I would suggest that in order to avoid the lamentable confusion that has resulted from the misuse of this designation that a new descriptive word be applied to the contraction of the nucleus in which the chromatin is found massed at one side of the vesicle, without regard to whether it is a normal phenomenon or not. To carry this idea I shall call this stage the "synizesis of the chromatin." "Synizesis'—the unilateral or central contraction of the chromatin in the nucleus during the prophase of the first spermatocyte. A term proposed to avoid the misuse of the word 'synapsis".

Evidently this is a move in the right direction but the definition of synizesis as given above must be extended to include

* Contributions from the Botanical Laboratory of the Ohio State University XXVIII.

†McCLUNG, C. E. The Chromosome Complex of Orthopteran Spermatocytes. Biol. Bull. 9:304–340, 1905.

similar contractions in other reduction cells, as microsporocytes and megasporocytes, or any other cells, in which a similar phenomenon is observed. Accepting this terminology as conducive to lucidity of expression, synapsis will then normally mean the process by which two univalent chromosomes become united to form one bivalent chromosome; or, in case a continuous spirem is formed by the end to end conjugation of univalent chromosomes, the process by which two univalent chromosomes become so united that at the time of the transverse segmentation of the continuous spirem they do not break apart as in previous divisions but are brought into the mother star as single bivalent pieces.

This will then include the idea expressed by the term, pseudo-reduction, which refers only to the fact that half as many chromatin pieces are present as in the previous division. Synapsis must not be confounded with the fusion of chromosomes in the network during each resting period nor with the ordinary fusion by which a continuous spirem is produced.

Recently the writer has studied a considerable number of preparations in order to refresh his mind upon this subject. The few figures presented are given merely as examples of a very large number of distinct types of chromatin contraction, which may be observed.

Some confusion has been produced by the use of the terms longitudinal and transverse division. Evidently it is of no importance whether two entire univalent chromosomes conjugate to form a ring, a twisted loop, or a simple longitudinally united or folded pair, so long as they separate during metakinesis. Transverse division means a qualitative division, longitudinal division a quantitative division. In such bivalent chromosomes as occur in the megasporocytes of *Lilium philadelphicum* (fig. 1), and *Erythronium albidum* and *americanum*, and in the microsporocytes of *Lilium tigrinum* the two limbs of the chromosomes lie folded on each other and twisted together. But the real reduction division is not so much the pulling apart of the two limbs but the transverse break in the loop at the head of the chromosome which is supposed to represent the point of the synaptic fusion of the pair of univalent maternal and paternal chromosomes.

Synapsis and reduction then are simply processes by means of which entire chromosomes, presumably maternal and paternal, are segregated into the daughter nuclei; or by which at least qualitative division of the chromatin is accomplished in case there is a mixing of paternal and maternal chromatin during the "$2x$" phase of the organism. The whole process appears to be merely a mechanical contrivance for bringing about qualitative separation. We may consider chromosome reduction as a necessary

stage in the life cycle of every sexual organism containing definite chromosomes. The fusion of the chromatin in synapsis cannot have any important effect on the hereditary characters of the chromosome. At the most the effect is probably the same as that which may be experienced in the fusion of the chromatin during each resting period of the nuclei in the entire history of the "$2x$" stage. It is the association of the chromosomes in the oospore and the subsequent vegetative history that appears to be of importance whether the chromosomes are closely mingled and fused or not. And it must be apparent that hereditary tendencies are active both in the resting stage of the nucleus and in the process of karyokinesis.

The early longitudinal splitting of the spirem in the first reduction division may be looked upon as a continuation of the usual process of vegetative karyokinesis, the quantitative separation of the daughter parts being interfered with by the intercalation of the synaptic stage. Since the separation or segregation of the univalent chromosomes follows immediately, a second division spindle is organized through the influence of the double chromosomes and thus normal nuclei are again produced by the distribution of the daughter halves. The mere presence of these chromosome pairs in the daughter nuclei resulting from reduction may be the cause of the rapid formation of the second spindle, and the explanation of the quite general presence of cell tetrads following the reduction division in both plants and animals. Yet it is hardly permissible to say that the first and second divisions are not true karyokineses. Nevertheless, the second divsion is a karyokinesis which had its beginning in the previous stage which was interrupted by the intercalation of the synapsis and reduction processes. The first spindle formed was taken advantage of by the bivalent chromosomes and the segregation following being of paternal and maternal double chromosomes the second spindle became necessary for the separation of the daughter pieces. In the first division the number of chromatin granules is not reduced although only half the original chromatin granules are represented in the daughter nuclei because of the transverse division of the chromosome as shown by me in the reduction division of *Lilium philadelphicum*.* In such cases as in the megasporocytes of Lilium, where the process of spore formation has been abbreviated, the vegetative division following the reduction is of the same nature as the second division when the usual spore tetrads are produced. This was definitely shown to be the case in my paper on *Erythronium albi-*

*SCHAFFNER, JOHN H. (Contribution to the Life-history of Lilium Philadelphicum). The Division of the Macrospore nucleus. Bot. Gaz. **23** : 430–452, 1897.

*dum.** Farmer and Moore† also consider that in the second karyokinesis we have a continuation of the longitudinal splitting begun during the first. We have thus a rational explanation of the observed facts—an explanation as to why when pseudo-reduction and qualitative reduction take place these processes are so generally followed by a second karyokinesis.

Accepting McClung's term, synizesis, for the massing or contraction of the chromatin in the prophase of division, the question remains to be settled as to whether this is a normal or an artificial production. Two methods seem available for the solution of this problem. One may study the effects of plasmolizing reagents on known structures and make comparisons or else one may attempt to study the stages in question from the living material.

In 1899‡ I found that a violent distortion of the chromatin and the so-called sickle stage of the nucleolus may be produced even in resting cells of the root tips of onions by using a violent killing fluid. This fluid was made according to the following formula:

Absolute Alcohol	95 cc.
Chloroform	5 cc.
Glacial Acetic Acid	1 cc.
Chromic Acid (8% H_2O Solution)	1 cc.

The combination proved to have a very bad effect as a killing reagent and was simply one of many tried in a series of experiments. Figures 5 and 6 represent cell rows from opposite sides of a section of onion root tip (*Allium cepa*) killed in this fluid. Nearly all of the nuclei of the peripheral cells showed decided distortions. The nuclei are crowded toward the outer walls of the cells, while the nucleoli are generally pushed in the opposite direction. The chromatin and other dark-staining material is also massed to some extent on the inner side of the nucleus. In the central strands there is little displacement althrough the cells are shrunken. No such distortions are ever to be seen in properly killed root tips and especially is there no such symmetrical arrangement of the nuclei and nucleoli in the outer layers of cells. This appearance then is purely on artifact which may be of assistance in the interpretation of other cases. In judging of synizetic contractions, it is also important to take into account the probable expansion of the nuclear cavity. The

* ————————. A Contribution to the Life-history and Cytology of Erythronium. Bot. Gaz. **31** : 369–387, 1901.

†Farmer, J. B., and Moore, J. E. S. On the Maiotic Phase (Reduction Divisions) in Animals and Plants. Quar. Jour. Mic. Sci. **48** : 489–551, 1905.

‡Schaffner, John H. Artificial Production of the Sickle Stage of the Nucleolus. Jour. App. Micr. **2** : 321–322.

cytoplasm is often expanded to a considerable extent by the killing fluids in common use. Figure 2 represents such a case. It represents the upper nucleus of a two-celled embryosac of *Lilium philadelphicum.* The killing fluid was the stronger chrom-acetic acid solution. The nucleus is in the resting stage and is not contracted as appears from a comparison with the lower nucleus of the same sac, where the cytoplasm is in the normal condition in contact with the nucleus. When the nuclear membrane has disappeared in the prophase of the reduction division the wall of the large vesicular nuclear cavity presents a favorable object for such expansions.

Recently Cardiff* has put forward the tentative opinion that the one-sided position of the chromatin mass is due to gravity. That this is not the case can easily be discovered by a study of cells whose position is known during life and during the killing process. Figures 3 and 4 are sections of microsporocyte tissue from the microsporangia of *Marsilea quadrifolia* sectioned in the original vertical position. The synizesis has been perfectly symmetrical. The chromatin knots all being toward the periphery, up and down and to both sides in central sections. Evidently gravity had nothing to do with the phenomenon, at least from a physical point of view. The action was apparently the same as in the case of the onion roots. The hard wall of the sporocarp was probably an important factor in producing the condition.

Some have supposed that the contraction is always around or in contact with the nucleolus. This is far from being the case. In the various plants investigated by myself one might, in individual preparations, even come to the opposite conclusion. The facts are that the chromatin may be massed around the nucleolus and have a central position in the nucleus as in Figure 9, which represents a microsporocyte of *Erythronium americanum,* or it may have a lateral position, in some cases merely touching the wall of the nuclear cavity, in others crowded closely against it. The nucleolus may appear on one side of the chromatin knot either connected with it or very loosely attached and appearing as if violently squeezed out of the chromatin mass during its contraction. Figures 7 and 8 representing microsporocytes of *Sagittaria latifolia* are typical examples of this condition. But very commonly the chromatin contracts away from the nucleoli, which then lie free in the nuclear cavity, or are crowded against the wall of the cavity and represent the "sickle stage". Figures 10 and 11 are microsporocytes of *Lilium tigrinum* which show these conditions. The synizetic knot is sometimes on the side of the nucleus lying against the greater mass of cytoplasm (Fig. 7)

*CARDIFF, IRA D. A Study of Synapsis and Reduction. Bull. Torr. Bot. Club **33** : 271-306. 1906.

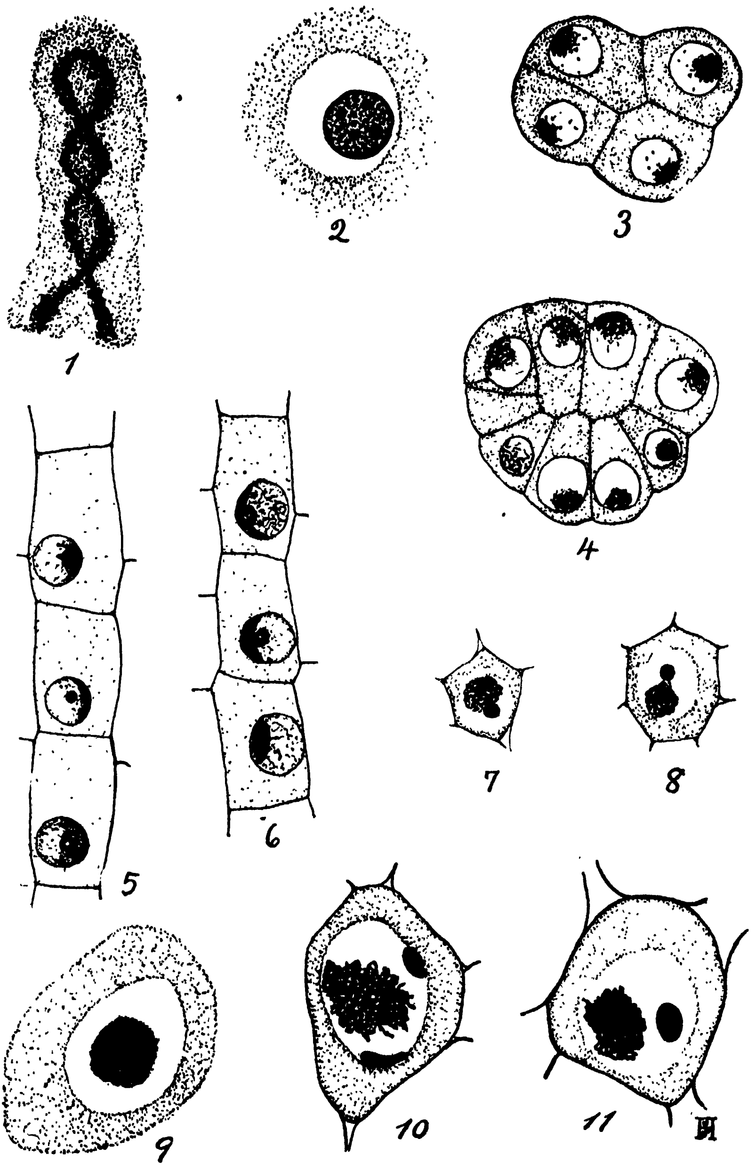
at others on the side where there is the least cytoplasm (Figs. 3 and 4). There is again no uniformity in this respect.

The variety of types of synizesis might be much increased but the examples given will make it plain that there is nothing uniform in the behavior of the chromatin in synizesis either with respect to the nucleolus or the nuclear cavity. Synizesis appears to be an artifact when considered from the standpoint of plasmolysis, but the question must be settled, if possible, through the study of living material. But if staining reagents are employed, great precautions are necessary even with living material. At the present stage of the subject it seems useless to continue the investigations by merely giving conclusions from a set of preparations which may present a supposed series of uniform conditions.

The results of this investigation may be briefly summarized as follows: The synizetic knot is not always around or in contact with the nucleolus but very commonly one may find it entirely distinct from the nucleolus. The chromatin is not always unilateral but very often central. If the knot is at one side it has no evident relation to the direction of gravity. Synizesis also does not mark the stage where the chromatin threads become homogeneous. In cases like *Lilium tigrinum* the chromatin granules, if properly stained, are seen at their best after the greatest possibility for contraction is passed. It seems from an investigation of the literature of the subject that there has been much speculation and reporting on "uniform conditions" simply because synizesis or "synapsis" has not been explained. But it is at present more important to discover the actual condition of things. The time at which synizesis occurs has not shown any uniformity. When one examines figures of this condition he is surprised at the lack of uniformity present. Some have even gone so far as to describe two "synapsis" stages before the formation of the mother star. During the early stages of division the nucleus is the seat of great chemical activity and the expansion of the nuclear cavity and changes in the chromatin network give rise to conditions which are especially favorable for the production of artifacts.

After the chromatin thread becomes thicker the contractions, as one would expect, are less common though by no means entirely lacking. Later when the orientation of the bivalent chromosomes begins, distortions are again abundant in many preparations. These series of distortions and contractions included under the term "synizesis" have at present no meaning and the mechanics of the process remains unexplained from the standpoint of a natural stage of karyokinesis.

OHIO NATURALIST. *Plate IV.*



SCHAFFNER on "Synapsis and Synizesis."

Explanation of Plate IV.

The figures were drawn with the aid of an Abbe camera lucida. Figure 1 was drawn with the Zeiss 18 ocular and Leitz 1-16 objective; the others with Zeiss 18 ocular and Zeiss 8.0 objective.

Fig. 1. A single bivalent chromosome from the reduction cell in the ovule of Lilium philadelphicum.

Fig. 2. Nucleus from two-celled sac of L. philadelphicum showing expansion of the cytoplasm.

Fig. 3. Microsporocytes of Marsilea quadrifolia showing centrifugal arrangement of the chromatin in synizesis.

Fig. 4. Microsporocyte tissue of Marsilea quadrifolia showing symmetrical synizesis.

Figs. 5 and 6. Cell rows from opposite sides of sections of Allium cepa showing the nature of artificial contraction.

Figs. 7 and 8. Microsporocytes of Sagittaria latifolia with nucleoli on one side of the contracted chromatin.

Fig. 9. Microsporocyte of Erythronium americanum showing central contraction of the chromatin around the nucleolus.

Figs. 10 and 11. Microsporocytes of Lilium tigrinum showing the independent contraction of the chromatin, the nucleoli being entirely distinct in the nuclear cavity.

WEATHER AND CROP YIELD.*

J. Warren Smith, Section Director, Weather Bureau.

I am convinced that the yield of most of our staple crops is affected greatly by favorable or unfavorable weather conditions during a comparatively short period of their growth.

Also that the yield can be very closely approximated at the close of this critical period by an exhaustive study of the weather conditions and crop yields of previous years.

The United States Weather Bureau is accumulating a vast amount of weather data that are being splendidly tabulated for use in studies of this character and considerable attention is being given to the subject.

In 1902 Professor W. D. Gibbs and myself charted some very interesting curves showing the relation between the yield of corn in the eight great corn producing states in this country, and the rainfall during June, July and August.

The period covered was from 1888 to 1902, and the states considered were Ohio, Indiana, Illinois, Iowa, Nebraska, Kansas, Missouri, and Kentucky.

The result showed that the yield was very little affected by the rainfall in August and not greatly affected by the rainfall during June. The curves, showed, however, that the rainfall in July controls the corn yield to a marked extent.

* Read at the meeting of the Ohio State Academy of Science.

The normal corn yield for these states is 28 bushels per acre, and the normal rainfall for July is 4 inches. Whenever the rainfall has approximated 5 inches, the corn yield has been over 32 bushels per acre. On the other hand whenever the rainfall has been less than 3 inches the yield has been less than 23 bushels per acre.

By taking the June and July rainfall together the rainfall curve and the yield curves agree even more closely than the July rainfall and yield curve.

The normal rainfall for June and July is 8 inches, while as stated above, the normal corn yield is 28 bushels per acre. Whenever the rainfall for these two months has averaged over 9 inches the corn yield has been 32 bushels or more, and when the rainfall has been less than 7 inches the yield has been below 25 bushels.

The best yield was 34 bushels an acre in 1902, when the June and July rainfall was over 11 inches. In 1896 the yeild was 33 bushels and the rainfall was almost 11 inches.

The lowest yield was less than 18 bushels per acre in 1901. The rainfall in June and July of that year was less than 6 inches and for July alone it was about 2 inches.

Other charts prepared for individual states show that by not including western Nebraska and Kansas, and eastern Ohio and Kentucky, and by considering carefully the rate of rainfall, and the length of periods with little or no rainfall, one can give a very close estimate of the yield of corn per acre in the United States, by the latter part of July; long before the crop is ready for harvesting.

We believe that a closer analysis of the daily data will show that the period during which a good corn yield is assured by good rains or seriously lessened by the lack of rain, is less than one month.

In 1904 the writer made a very exhaustive study of the weather and the yield of various corps in Fulton County, Ohio, from 1874 to 1903 inclusive.

The data showing the yield of corps were obtained from the records of the Secretary of State, but the weather records, as well as many valuable records of farm operations, the advance of vegetation, the flight of birds, the blossoming, leafing, etc., of trees, shrubs and plants, were obtained of Hon. Thomas Mikesell of Wauseon. This gentleman has a most remarkable record of phenological observations since 1869—I know of no more complete and exact record in this country than these.

Charts were made showing the departure of the average temperature and total rainfall from the normals, by months from January 1876 to 1904, and the departure of the different crop yields from the normal for the same period.

By a comparison of these curves it is comparatively easy to see the relation between the weather and crop yield, insofar as the average temperature and total rainfall of *whole* months affect the yield. It is apparent, however, that for some of the crops the period of usually favorable or unfavorable weather are less than one mônth in length and are not shown in the monthly data.

It is probable that wheat, for example, is affected by alternate freezing and thawing, short periods of severe cold, snow covering, etc., more than by monthly temperature of precipitation conditions. The February preceding the lowest wheat yield of the period gave the coldest week ever experienced in many sections of the State. The low yield of 1875 was preceded by the coldest winter on record, that of 1896 was preceded by a very cold January and that of 1900 by a cold February and March. The good yields of 1891, 1984 and 1898 were preceded by mild winters.

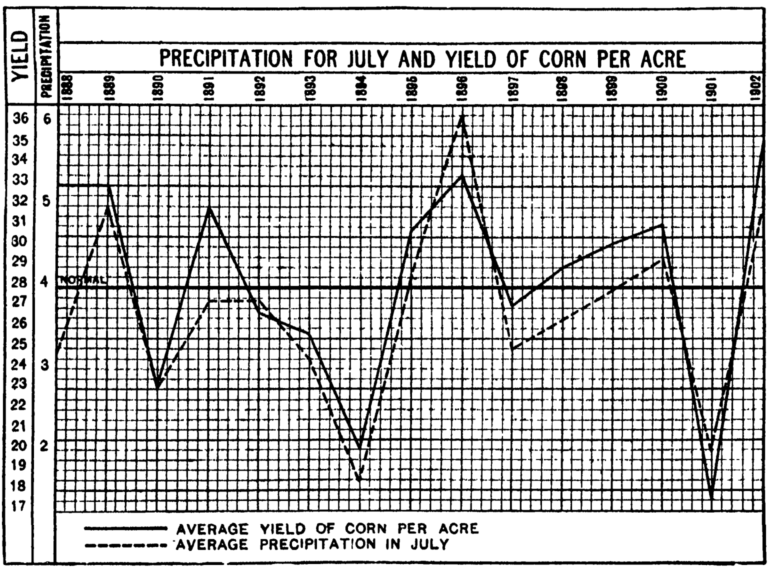


FIG. 1. Precipitation for July and yield of corn per acre.

The relation between the yield of corn and the rainfall in July is not so well marked in a small district as in a large one, yet nearly every year with a large corn yield in this county had a July rainfall above the normal, and nearly every year with a small yield of corn had a small July rainfall. One exception, however, was the year 1883 which had a July rainfall above the

normal yet gave the lowest corn yield on record. This is accounted for by the fact that the whole summer was cold and wet; the number of days between the spring and fall frosts was the least on record.

It is very apparent from the charts that to produce the best yield of oats June and July or both must be moderately cool and dry.

Barley is not so important in this county but from the records given the summer should be warm and dry.

The best potato years have been those with a cool summer, with a fair amount of rain in June and July and with a dry September.

Rye and clover are affected by winter conditions much as wheat is affected. The best yields of hay other than clover are with an abundant rainfall in April, May and June.

The dates of blossoming of fruits depends to a marked degree upon the temperature of March and April. In general poor fruit yields have been preceded by cold winters and good yields by comparatively mild winters.

STELLATE HAIRS AND PELTATE SCALES OF OHIO PLANTS.

Edna M. McCleery.

All hairs and scales serving merely as a covering, without reference as to their origin, have practically one function, that of protection. They serve as a protection in two ways; first, by preventing evaporation by the wind, and second, by preventing the direct rays of the sun from shining on the surface of the leaf and thus causing excessive transpiration and injury to the chlorophyll. With this function in mind it is easily seen how much more effective the interlaced points of stellate hairs or scales would be, than simple short hairs.

There are two divisions of stellate pubescence; first, that in which the leaf is covered with hairs having a star shaped or many-pointed top and a single stalk by which they are attached to the surface of the leaf, and second, that in which the leaf is covered with simple hairs arranged in tufts from one point. The illustration given of a stellate hair of Lepargyraea canadensis (Fig. 3) shows plainly the many-pointed top and the single stalk. The stellate hairs of Croton monanthogynus (Fig. 7) and of the Solanums (Figs. 17, 18, 19) do not have the long stalks on the under side by which they are attached to the surface of the leaf, but instead they are almost sessile. They have, however, a single point or branch which rises from the center and stands at right angles to the remainder of the hair and to the surface of the

leaf. On the hairs of Solanum carolinense there are usually four spreading points and a single erect one, but the number of points on the other Solanums, the Crotons and on Lepargyraea vary greatly. On these plants we find the more typical forms of true stellate hairs.

The second type of stellate pubescence is shown in the figures of Hicoria minima (Figs. 11, 12) Helianthemum canadense (Figs. 22, 23) and Viburnum alnifolium (Figs. 25, 26). In these the single hairs are arranged from a common point on the surface and spread in many directions. Hairs arranged in this manner are called stellate tufts.

The hairs of Hicoria minima are rather heavy, and there are very seldom more than four in the tuft. A great many of the tufts have only two hairs. The single hairs of the Helianthemum are barbed and a little more slender than those of the hickory. The number of hairs in a tuft varies but tufts made up of from six to fifteen are the most common. The single hairs of Viburnum alnifolium are very long and slender, and being very much twisted and intertwined give a true tomentose covering to the leaf. The number of hairs in a tuft varies, but most frequently there are from ten to twenty.

The Lepargyraea has peltate scales along with the stellate hairs. In fact the transition is very gradual, and there are some intermediate forms which could be placed either with the scales or the hairs. Usually though they fall into three rather distinct divisions: the brown scale (Fig. 1), the white scale (Fig. 2), and and the white stellate hair (Fig. 3). The stellate hairs of Hicoria minima and other species are also found associated with scales (Figs. 8, 9, 10), but the scales are entirely different from those of Lepargyraea. There is also a sharp distinction between the hairs and the scales of the hickory, no transition forms being present. The scales of Hicoria minima are rather large, yellowish green or brown in color and attached to the leaf by a very short stalk. Those of Hicoria alba are smaller and brown in color, and those of Chamaedaphne calyculata are also of the same type. They are of a typical peltate shape and are multicellular.

Ohio Plants Which Have Stellate Pubescence.

Juglans cinerea L., leaves stellate tufted.

Hicoria ovata (Mill.) Britt., twigs stellate tufted, leaves finely stellate tufted.

Hicoria laciniosa (Mx.f.) Sarg., leaves stellate tufted.

Hicoria glabra (Mill.) Britt., leaves stellate tufted, only slightly above.

Hicoria alba (L.) Britt., twigs stellate tufted, leaves tomentose-stellate tufted.

Quercus nana (Marsh.) Sarg., leaves stellate tufted above when young.

Quercus marylandica Muench., leaves stellate tufted above when young.

Quercus minor (Marsh.) Sarg., leaves stellate tufted above.

Quercus prinoides Willd., young leaves sparingly stellate tufted above; mature leaves stellate tufted beneath.

Polygonum arifolium L., leaves stellate tufted beneath.

Bursa bursa-pastoris (L.) Britt., leaves stellate tufted.

Camelina sativa (L.) Crantz, leaves stellate tufted.

Camelina microcarpa Andrz., leaves stellate tufted.

Draba verna L., twigs and leaves stellate tufted.

Draba caroliniana Walt., twigs and leaves stellate tufted.

Stenophragma thaliana (L.) Celak., twigs and leaves stellate tufted.

Alyssum alyssoides (L.) Gouan., twigs and leaves densely covered with stellate hairs.

Hamamelis virginiana L., leaves stellate tufted.

Croton capitatus Mx., twigs and both sides of leaves densely covered with stellate hairs.

Croton monanthogynus Mx., twigs and both sides of leaves densely covered with stellate hairs.

Althaea rosea Cav., leaves densely stellate tufted.

Malva rotundifolia L., leaves stellate tufted beneath.

Malva moschata L., leaves stellate tufted beneath.

Callirrhoe involucrata (T. and G.) Gr., twigs and leaves stellate tufted.

Napaea dioica L., twigs and leaves stellate tufted.

Abutilon abutilon (L.) Rusby, leaves densely stellate tufted.

Hibiscus moscheutos L., twigs stellate tufted, leaves stellate tufted, more dense beneath.

Helianthemum majus (L.) B. S. P., leaves stellate tufted above.

Helianthemum canadense (L.) Mx., leaves stellate tufted above and below.

Lepargyraea canadensis (L.) Greene., leaves covered with stellate hairs, sparingly above, but densely beneath.

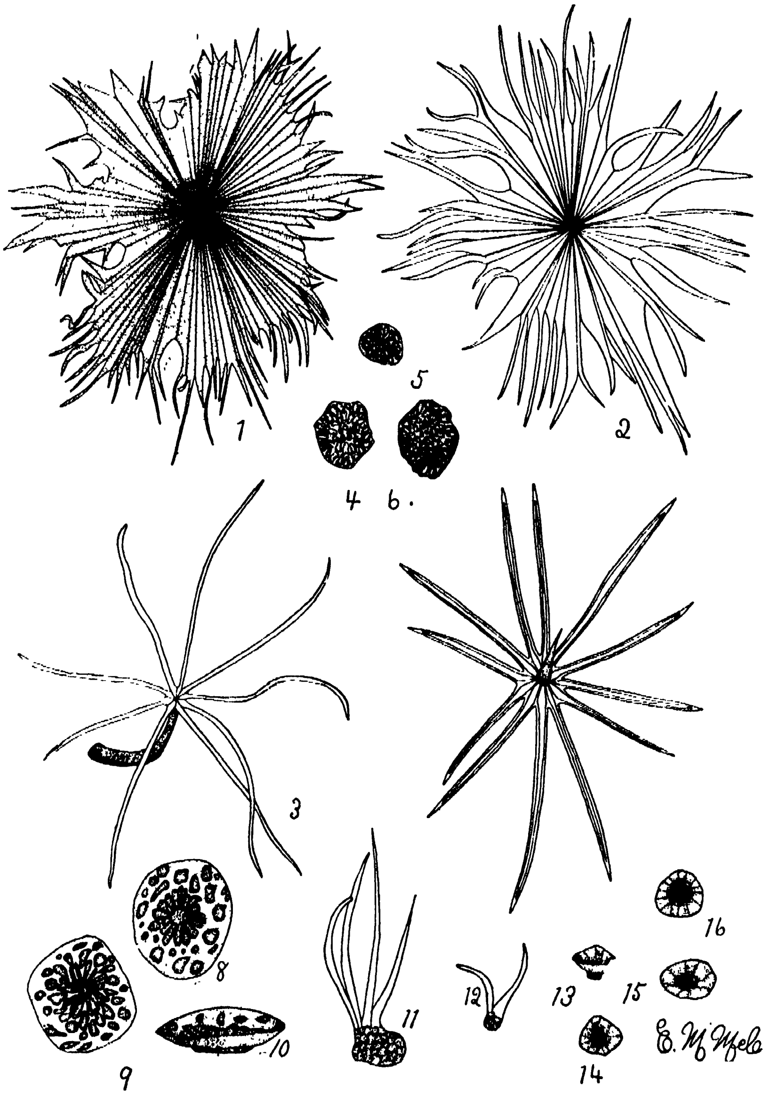
Solanum carolinense L., twigs and leaves covered with stellate hairs.

Solanum elaeagnifolium Cav., twigs and leaves covered with fine stellate hairs.

Solanum rostratum Dunal, twigs and leaves covered with stellate hairs.

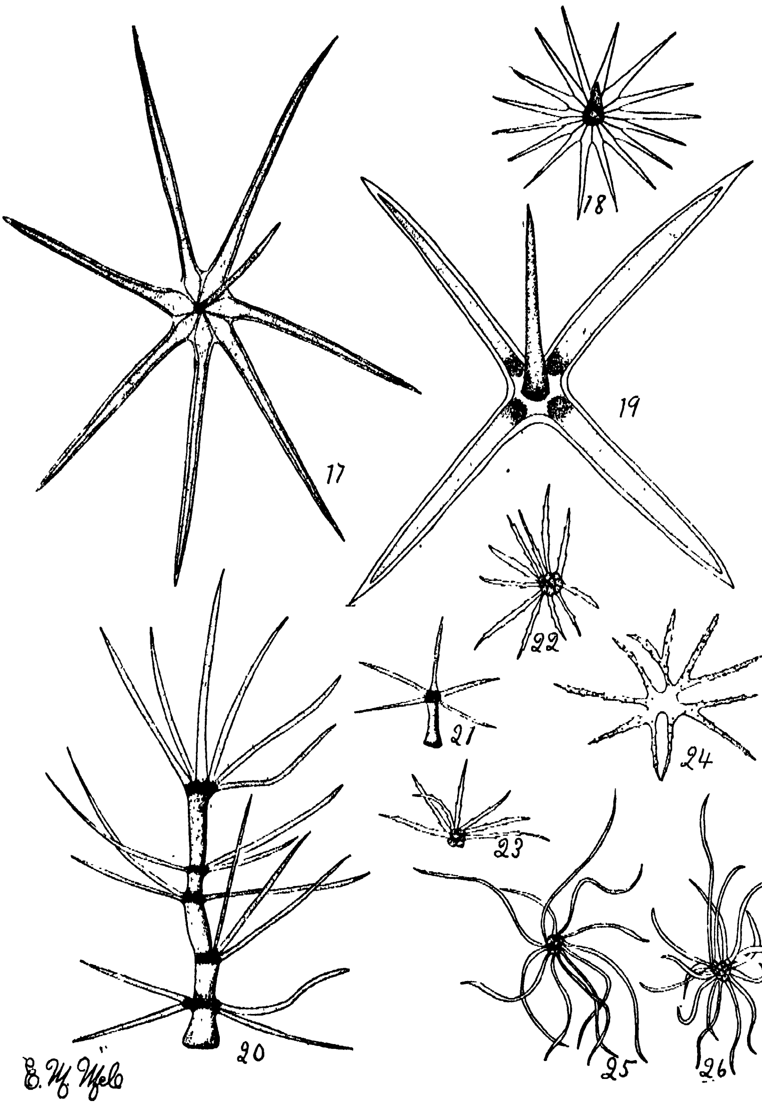
Verbascum thapsus L., twigs and leaves densely covered with branched and stellate hairs.

OHIO NATURALIST. *Plate V.*



McCLEERY on "Stellate Hairs and Peltate Scales."

OHIO NATURALIST. *Plate VI.*



McCLEERY on "Stellate Hairs and Peltate Scales."

Viburnum alnifolium Marsh., twigs and leaves stellate tufted; more dense on twigs and on veins on under side of leaves.

Viburnum acerifolium L., leaves stellate tufted beneath.

Viburnum pubescens Ph., leaves stellate tufted beneath.

Viburnum molle Mx., leaves stellate tufted beneath.

Viburnum lantana L., twigs and leaves densely stellate tufted; leaves more dense beneath.

Ohio Plants Which Have Peltate Scales.

Hicoria minima (Marsh.) Britt.
Hicoria ovata (Mill.) Britt.
Hicoria laciniosa (Mx. f.) Sarg.
Hicoria alba (L.) Britt.
Hicoria microcarpa (Nutt.) Britt.
Hicoria glabra (Mill.) Britt.
Lepargyraea canadensis (L.) Greene.
Chamaedaphne calyculata (L.) Moench.

This list does not include plants having scales which are glandular or whose function is mainly the excretion of resinous material.

Explanation of Plates V. and VI.

Figs. 1, 2. Peltate scales of Lepargyraea canadensis.
Fig. 3. Stellate hair of Lepargyraea canadensis.
Figs. 4, 5, 6. Peltate scales of Chamaedaphne calyculata.
.Fig. 7. Stellate hair of Croton monanthogynus.
Figs. 8, 9. Peltate scales of Hicoria minima; top view.
Fig. 10. Peltate scale of Hicoria minima; side view showing stalk.
Figs. 11, 12. Stellate tufts of Hicoria minima.
Fig. 13. Peltate scale of Hicoria alba; side view showing stalk.
Figs. 14, 15, 16. Peltate scales of Hicoria alba.
Fig. 17. Stellate hairs of Solanum rostratum.
Fig. 18. Stellate hair of Solanum elaeagnifolium.
Fig. 19. Stellate hair of Solanum carolinense.
Fig. 20. Branched hair of Verbascum thapsus.
Fig. 21. Stellate hair of Verbascum thapsus.
Figs. 22, 23. Stellate tufts of Helianthemum canadense.
Fig. 24. Dichotomously branched stellate hair of Alyssum alyssoides.
Figs. 25, 26. Stellate tufts of Viburnum alnifolium.

COLOR OF OHIO FLOWERS.

CLARA G. MARK.

From earliest times the flowering plants have received a great degree of attention, which no doubt is attributable for the most part to their varied and often brilliant colors. There have been many curious beliefs and theories with regard to the coloring of flowers, both as to its cause and as to its significance. Of these theories the one that has been most generally accepted in modern times is that the color of flowers is a device to attract animals, particularly insects, which may serve to carry pollen from one flower or plant to another. That insects are sometimes attracted by color has been proved; but it has been demonstrated that a color sense is almost wholly lacking except in the higher insects, and when present has been developed in comparatively recent times. This precludes the idea of color attraction in so far as at least a part of the pollen-carrying insects are concerned, and it gives weight to the probability that a majority of such insects are attracted by the form and odor of flowers rather than by their color. It follows that while the attraction of pollen-carrying insects may be in some cases one of the incidental results of the coloring of flowers, it can hardly be said to be the primary purpose of such coloring. The supposition at the present time is that the purpose of the coloring in the flower is to increase the temperature to a greater or less degree and so stimulate the activity of the protoplasm; also the colored parts of the flower may serve as a screen to protect the more delicate reproductive parts from the action of the direct rays of the sun.

The two principal classes of pigments occurring in flowers are the lipochromes and the anthocyans. The lipochromes vary through the different tints of yellow, orange and dull red and occur in the flowers as crystalloids. The anthocyans form a series of substances varying from red to blue and violet and are always found in solution in the cell sap. The color of a flower may be due to the presence of one or both of these classes of pigments. It has been found by experiments that flowers of different colors show a marked difference in temperature when exposed to the same conditions of light, moisture, etc.

In studying the Ohio angiosperms with regard to the coloring of the flowers, they were first divided into two general groups: First, those without typical floral parts, such as grasses and sedges; second, those with typical floral parts. This second group was again separated into two divisions: First, those in which the flower or flower cluster is so large as to be conspicuous; second, those in which the flower or flower cluster is inconspicuous. Record was kept in a general way of the seasons of

blooming as spring, summer and fall. In many cases the period of blooming extends through two seasons and often through all three. A few plants, such as Taraxacum, were found to be in bloom practically throughout the entire year. In keeping a record of the various colors, for the sake of convenience nine general headings were used. These are white, violet, purple, blue, green, yellow, orange, red and pink. Many of the species studied produce flowers of more than one color, though in most cases the variation is confined to different shades or tints of the same color. In many of the species that typically produce bright colored flowers occasional white flowers are found. Examples of this are Mertensia and the Giant Habenaria, the flowers of the former being typically blue and those of the latter violet. No note was taken of these occasional white flowers, as they were thought to have been caused by exceptional conditions.

About two thousand angiosperms were examined, which includes practically all in the Ohio flora. Of these about five hundred were discarded, being grasses, sedges, etc., without typical flowers. The remaining fifteen hundred are divided among the different colors as follows: white, 538, or 35.86% of 1500; violet, 170, or 11.33%; purple, 193, or 12.86%; blue, 136, or 9.06%; green, 160, or 10.66%; yellow, 380, or 25.33%; orange, 21. or 1.4%; red, 70, or 4.66%; pink, 160, or 10.66%.

Of the fifteen hundred plants with typical flowers, 1040 have conspicuous flowers and the remaining 460 inconspicuous. Eight hundred and three of the species with conspicuous flowers are native and 237 introduced; of the inconspicuous 350 are native and 110 introduced.

With regard to color the record for these two divisions is as follows:

	Conspicuous—1040			Inconspicuous—460		
Color	Number	% of 1500	% of 1040	Number	% of 1500	% of 460
White	383	25.53	36.826	155	10.33	33.7
Violet	127	8.46	12.211	43	2.86	9.12
Purple	144	9.6	13.846	49	3.26	10.65
Blue	98	6.53	9.423	38	2.53	8.26
Green	47	3.13	4.519	113	7.53	24.565
Yellow	291	19.4	27.98	89	5.93	19.34
Orange	21	1.4	2.019	0	0	0
Red	59	3.93	5.673	11	.73	2.39
Pink	128	8.53	12.307	32	2.13	6.95

It will be seen from this table that the percentage of green flowers among the inconspicuous is much higher than among the conspicuous, while the percentage of flowers of each of the other colors falls a little below the percentage of those of the same color among the conspicuous flowers.

In the following tables the principal division is made with regard to the time of blooming, the three seasons, spring, summer and fall, being used. While a few species are found in bloom in the winter it was not considered necessary to keep a record of them.

SPRING.

	Conspicuous	Inconspicuous	Total	% of 1500	% of 605
All Colors	416	189	605	40.33	100
White	179	69	248	16.53	40.99
Violet	42	7	49	3.26	8.09
Purple	52	13	65	4.33	10.74
Blue	48	17	65	4.33	10.74
Green	22	52	74	4.93	12.23
Yellow	96	30	126	8.4	20.82
Orange	7	0	7	.46	1.15
Red	17	6	23	1.53	3.80
Pink	43	9	52	3.46	8.59

SUMMER

	Conspicuous	Inconspicuous	Total	% of 1500	% of 1156
All Colors	776	380	1156	77.06	100
White	259	121	380	25.33	32.87
Violet	93	43	136	9.06	11.76
Purple	114	47	161	10.73	13.92
Blue	67	34	101	6.07	8.73
Green	27	82	109	7.20	9.42
Yellow	232	74	306	20.4	26.47
Orange	18	0	18	1.2	1.55
Red	50	9	59	3.93	5.10
Pink	94	21	115	7.66	9.94

FALL

	Conspicuous	Inconspicuous	Total	% of 1500	% of 627
All Colors	401	226	627	41.8	100
White	125	59	184	12.26	29.34
Violet	61	37	98	6.53	12.44
Purple	59	29	88	5.86	14.03
Blue	43	23	66	4.4	10.53
Green	9	50	59	3.93	9.409
Yellow	141	43	184	12.26	29.34
Orange	9	0	9	.6	1.43
Red	20	8	28	1.86	4.46
Pink	33	12	45	3.	7.16

If the percentages of the different colors for each season are examined it will be seen that the percentages of white and green flowers are greatest in the spring and least in the fall, while the percentages of violet, purple and yellow flowers are least in the spring and greatest in the fall.

WINTER KEY TO THE OHIO SPECIES OF EUONYMUS.

DALE CONDIT.

Euonymus. Small trees or erect or trailing shrubs with opposite leaf scars; twigs usually four-angled, green or greenish; terminal bud present with 6–10 acute or obtuse scales; axillary buds single, sessile; leaf scars semicircular to crescent shaped, with one bundle scar; stipular scars none, pith solid, rhombic, white or greenish; bark more or less bitter; self-pruning scars present in some species; fruit a more or less fleshy colored capsule; the seeds with a brilliantly colored aril.

1. Low, trailing, ascending or erect, shrubs, often rooting from the stem; apical pair of bud scales usually much longer than the other pairs and forming a slender conical point; bud scales thin, flexible; capsule tuberculate. 2.
1. Small trees; bud scales thickened and having an elevated keel; terminal buds transversely four-angled, short and obtuse or long and acute; capsule smooth. 3.
2. Trailing decumbent shrubs, seldom rising 2 feet above the ground and rooting from the prostrate stems; bud scales obtuse; twigs soft and flexible. *E. obovatus* Nutt. Running Strawberry Bush.
2. Erect or ascending shrubs 2–8 feet high; bud scales more acute, thin. *E. americanus* L. American Strawberry Bush.
3. Buds acute, long; bud scales acute; bark very bitter; aril red. *E. atropurpureus* Jacq. Wahoo.
3. Buds obtuse, short; bud scales usually very obtuse; bark only slightly bitter; aril yellow. *E. europaeus* L. Spindle-tree.

ADDITIONS TO THE OHIO FLORA FOR 1905-6.

FREDA DETMERS.

The following plants have been added to the State Flora since the last report, made in 1903-4. It has been customary to report only those of which there are specimens in the State Herbarium, however, this list contains exceptions to this rule. Two plants are included which are not in the Herbarium of the University; both are reported on good authority and one is in the Herbarium of the Ohio Agricultural Experiment Station at Wooster, also a state herbarium.

Coronilla varia L. In the Herbarium of the Ohio Agricultural Experiment Station, Wooster, O. Collected by M. M. Murphy, Ripley, O., June 1899. It was reported by Mr. A. D. Selby. I quote from Mr. Selby's letter: "Mr. Murphy wrote that the specimens had become well established and that he had observed the plant for several years."

Danthonia compressa Austin. Collected by Roscoe J. Webb, Garrettsville, Portage County, July 8, 1906.

Hartmannia speciosa (Nutt.) Small. (Oenothera speciosa Nutt.) Collected by Thomas S. Earl, along Railroad track, Columbus.

Polystichum acrostichoides (Mx.) Schott, var. incisum Gray. (Dryopteris acrostichoides var. incisum). Collected by L. S. Hopkins, Wayne County, July 25, 1905.

Trillium declinatum (A. Gray) Gleason, n. sp. Reported for Ohio by Gleason in Torr. Bull. Bot. Club VII:389. July, 1906.

Wolffiella floridana (J. D. Smith) C. A. Thompson. Determined by C. A. Thompson. Collected by W. A. Kellerman, Buckeye Lake, Licking County. Oct. 19, 1906.

AN INTERESTING BOULDER OF CUYAHOGA COUNTY.

EDO CLAASSEN.

Among the many boulders of Northern Ohio, which represent granite, amphibolite, gneiss and other rocks, one occasionally finds a specimen more interesting than usual. It is such a piece of rock that is lying partly imbedded in the ground on Superior Avenue, west of Forest Hill Park, in East Cleveland Township near the top of a hill, several hundred feet above Lake Erie. The boulder is evidently gneiss and has a nearly flat surface of an oval shape, when seen from above. It has a circumference at the surface of the ground of about nine feet, a somewhat cleavable structure, produced by the quartz having been mostly deposited in layers and, while a considerable amount of

quartz is present, but very little biotite is found and apparently no feldspar. Instead of the last named mineral, however, a great number of brown garnets occur to such an extent as to give the rock a brownish appearance. The largest ones are more than one eighth of an inch in diameter. Among the whitish quartz and between its layers they produce a very striking appearance, lying mostly separated from each other. On the surface, where the rock is disintegrated, the garnets number about fifteen to eighteen to the square inch, lying in grooves of greater or less depth, thereby giving the surface of the rock a dotted appearance.

MEETING OF THE BIOLOGICAL CLUB.

Orton Hall, Nov. 5th, 1906.

The meeting was called to order by the President, Mr. Griggs. After the Club came to order the minutes of the previous meeting were read and approved.

Prof. Osborn, as chairman of the committee on nominations of officers, reported the following names: President, J. C. Hambleton; Vice President, C. R. Stauffer; Secretary and Treasurer, J. N. Frank.

On the motion of Prof. Schaffner the report was adopted as read.

Prof. Hambleton then took the chair.

Prof. Osborn then reported the work of the committee appointed to make arrangements for entertaining the Ohio Academy of Science during its annual meeting.

Prof. Griggs then gave the annual address of the retiring President on "A Comparison of the Forests of the West Coast with those of the Tropics."

Prof. Hubbard reported a remarkable case of variation in the drift east of Goodale Park.

Mr. Lon Hawkins was elected to membership.

The Club then adjourned.

Z. P. Metcalf, Secretary.

Date of Publication of January Number, January 15, 1907.

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THE COLUMBUS ESKER.

WILLIAM CLIFFORD MORSE.

TERMINOLOGY.

The terms employed in this discussion have been used in various senses by different writers. Their application has been gradually restricted by a series of steps which the author will trace at the outset. Wright (1), in his chapter on kames, says: "The word 'kame' has already been defined as a local term applied to the sharp, gravel ridges which abound in various parts of Scotland, and which in Ireland are called 'eskers', and in Sweden 'osars'. As Geikie's work on 'The Great Ice Age' has given currency to the Scotch name, and as the word has been adopted by those who have investigated this class of formations most fully in America, it seems best to continue its use, though either of the names is more euphonious."

Wright's subsequent application of this term (kame) is to North American formations, which Geikie would have, at least in his third edition of "The Great Ice Age", (2) differentiated as osars and kames, if not by further distinctions. The former are defined by him as "ridges of gravel, etc., which coincide in direction with the trend of the glaciation—they follow, in short, the path of the ice sheet"; the latter as "Kames of gravel, sand, etc., which are typically developed in the Lowlands opposite the mouths of mountain-valleys, and which, when followed up such valleys, pass eventually into ordinary morainic accumulations." Not only does Geikie clearly distinguish between osar or esker on the one hand and kames on the other, but Chamberlin (3)

1. WRIGHT, G. FREDERICK. The Ice Age of North America, p. 297, 1891.
2. GEIKIE. Great Ice Age, Third ed., p. 205, 1894.
3. IBID, p. 745.

further emphasizes this distinction in his contribution (Glacial Phenomena of North America) to this volume. In defining these he says of osars or eskers: "These terms are restricted to the long, gravel ridges which conform, in general, to the direction of the ice-movement, and which are thought to represent the main drainage lines of the glaciers in their later stages, particularly when they approach a stagnant condition. The term kames, on the other hand, is applied to those gravel accumulations which take on the form of bunchy aggregations of knolls and irregular ridges, and have the tendency to arrange themselves in belts parallel to the margin of the ice. They frequently accompany terminal morains and have a quasi-morainic aspect."

In his thorough work on "The Glacial Gravels of Maine," under the head of "Sediments Transported by Glacial Streams," Stone (4) states that: "The simplest form is that of a cone, dome or hummock, and we find all transitions between these forms and the elongated, two sided ridges." "These gravel deposits have such curious and distinctive shapes that they have received local names wherever they occur. The Scandinavian osars, the Irish eskers (or eskars or eschars) and the Scottish kames are supposed to be the equivalents of the gravel ridges here described, or nearly related to them. These deposits contain matter of various sizes from fine clay to large bowlders, but gravel is by far the most abundant. I have found the term *glacial gravel* a convenient general title for describing every kind of coarse sedimentary formation which was deposited by glacial streams. The term has the disadvantage of implying a theory as to the origin of these sediments, and it does not describe their composition in all cases, yet it is often convenient as a generic name when there is doubt what specific name should be given to a certain deposit, whether kame, osar, etc." In chapter IV, "General Description of the Systems of Glacial Gravel," the term osar is exclusively used for these systems. These are described as comprising the sediments deposited by a single glacial river with its tributary and delta branches. Stone, in Chapter VI, quotes Chamberlin's distinction between the osar or esker on the one hand and kame on the other. He carries it a step further, however, and applies esker to the separate mounds and ridges of a series of separated deposits known as a discontinuous osar.

In his exhaustive works, "The Illinois Glacial Lobe" (5) and "Glacial Formations and Drainage Features of the Erie and Ohio Basins," (6) Leverett uses exclusively the term esker for these gravel ridges whose longitudinal axes correspond to the local axis of the ice sheet. Whether intentionally or otherwise this

4. Monograph XXXIV. U. S. G. S. p. 34.
5. Monograph XXXVIII. U. S. G. S., 1899.
6. Monograph XLI. U. S. G. S., 1902.

application conforms to the restriction placed upon the term by Stone, for these gravel ridges are, as a whole, both short and interrupted.

Chamberlin and Salisbury ([7]) in their recent work, use osar or esker and kame in the same sense that Chamberlin used them in "The Great Ice Age" mentioned above. The limits of the terms are perhaps a little more sharply drawn.

Thus we see that at the beginning in Sweden the term osar was applied to these gravel ridges. Ireland developed the term esker for them while in Scotland they were called kames. Later these terms were used interchangably for these formations in other parts of the world. Still later Geikie in Scotland and Chamberlin in America restricted the term kame to those gravel bunches and ridges which stood in more or less close relation to the terminal moraines and applied osar or esker to the others, *i. e.*, those parallel with the flow of the ice tongue. More recently Stone limits esker to short interrupted osar while esker alone is employed by Leverett in his works. Because of these well defined usages, osar or esker on the one hand and kames on the other should not now be used interchangeably. It would, perhaps, have been better also to have differentiated between osar and esker as used by Stone, in the second best developed field in the world, but Geologists in subsequent papers have not accepted this latter distinction.

General on Eskers.

The place best fitted for the development of osars and eskers seems to have been a zone just within the periphery of the ice-sheet, at its maximum extension or at its subsequent stages of retreat. They may rest upon the bed rock or upon till stratified or unstratified. As before stated, they follow more or less closely the direction of the ice-flow as shown by the striae on the bed rock. They quite often follow the valleys of their region, but striking exceptions to this occur. Not infrequently they extend from a stream valley up and across a low divide of 200 feet (sometimes 400 feet) and down again into a valley on the other side. Instances are recorded where they cross a lake, their top not only sinking below the adjacent valleys, but below the surface of the water as well.

Parts of Europe and North America were especially well adapted for their formation. In Sweden they reached their culmination. Here they not infrequently extend for over a hundred miles from the interior to the sea. Their height varies from 0 to 180 feet but probably is more often found to be between 50 and 100 feet.

7. Geology, Vol. III. pp. 373-376 and 368-371, 1906.

As previously stated they are also to be found more or less abundantly in the Lowlands of Scotland and in Ireland. In the former country they usually rise abruptly from the till to a height of 20 to 30 feet and with a width of 100 to 400 feet. Those in the latter country are remarkable for frequently being dotted over with large erratics.

Turning to our own country we find their greatest development in Maine. In fact these are second to none unless it be to those of Sweden. Not only are they the greatest but more pages of minute description and more hypotehses to explain their formation have been written than of those in any other locality. Some fifty systems have been described by Stone. A few of these systems attain a length of 100 miles and some 125 miles. When we consider that each of these systems comprises the sediments deposited by a single glacial river with its tributary and delta branches and that they frequently consist of a number of short ridges we see the magnitude of their development.

Eskers are much less strikingly developed in other New England states, in New York, Pennsylvania, Ohio, Indiana, Illinois and Wisconsin. These are mostly short gravel ridges. Sometimes they can be seen to comprise a system.

For Ohio these have been worked out in some detail. Leverett has described, in Monograph XLI of the United States Geological Survey, eleven such gravel ridges as follows:

The Circleville Esker, Pickaway Co., pp. 429–431.
The esker in Fairfield Township, Huron Co., p. 597.
The Hartland Esker, Huron Co., pp. 615–617.
The Leesville Esker, Crawford Co., p. 542.
The esker near Norwalk, Huron Co., pp. 587–588.
The Pickerington Esker, Fairfield Co., pp. 428–429.
The Radnor Esker, Delaware–Marion Cos., pp. 540–541.
The Richland Esker, Logan Co., pp. 489–490.
The Richwood Esker, Union Co., p. 540.
The esker near Springboro, Warren Co., pp. 332–333.
The Taylor Creek Esker, Hardin Co., pp. 538–540.

All of these are 3 miles or less in length, except the Circleville and Pickerington eskers which are 9 and 5 miles respectively.

THE COLUMBUS ESKER.

In the northeastern part of the city of Columbus is a ridge, the location of which has been known for a long time, but whose structure and composition were, probably, not recognised until last Spring, when it was the writer's good fortune to detect it. Workmen had excavated a ditch across its northern end for a water main, which exposed its alternate strata of sand and gravel to view. This gravel ridge probably ought to be described because of its convenient location, especailly to the Ohio State

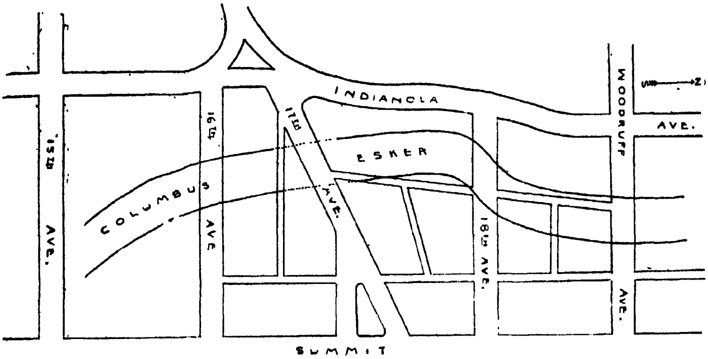

FIG. 1. Chart showing location of the Columbus Esker. The dotted portion shows where the ridge has been eroded by a small branch of Neil's Run, Seventeenth Avenue occupying the position of this branch.

FIG. 2. General view of the esker from a point near Seventeenth Avenue looking north. The shed is located upon the center of the ridge just north of Eighteenth Avenue, where there is a sharp turn to the east and thence northward.

University, and because of the rapid growth of this part of the city. The "leveling" hand of man will all too soon obliterate its distinctive features.

The trend of this esker is north to south between Summit Street on the east and Indianola Avenue on the west (Fig. 1).

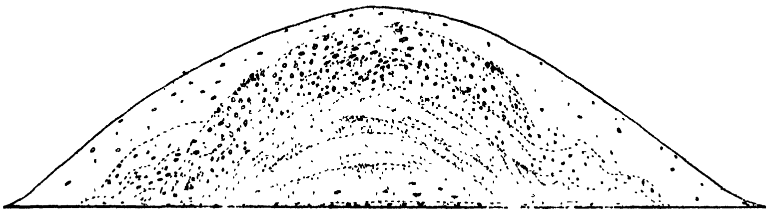

FIG. 3. A diagram of the cross section of the esker on the north side of Woodruff Avenue, width 128 feet, height 16 feet, 8 inches.

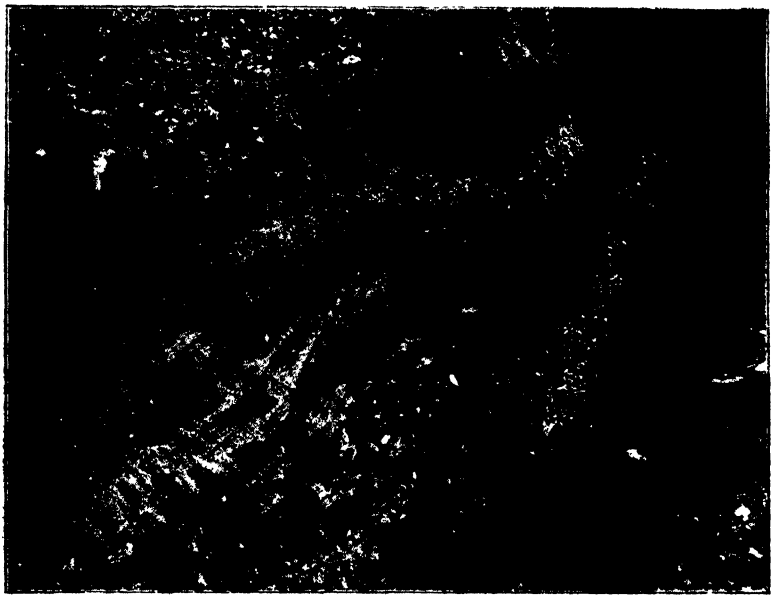

FIG. 4. A portion of the cross section of the esker on the north side of Woodruff Avenue. On account of the narrowness of the water-main ditch it was necessary to take the photograph at quite an angle.

It extends from the bank of Neil's Run 150 feet north of Woodruff Avenue south to Fifteenth Avenue. The residence of the Neil estate is located upon its southern end. A portion of the

ridge has been eroded by a small branch of Neil's Run, which crosses it just north of Sixteenth Avenue.

A cross section (Figs. 3 and 4) at the northern end exposed by the excavation for Woodruff Avenue shows it to be 128 feet wide and 16 feet, 8 inches high. Here it rests directly upon the bed rock, the Ohio Shale. The bottom layer of 12 inches contains a great number of angular and partly water-worn pebbles of the adjacent shale (Fig. 4). The strata of the large central core dip outward from 20 ° to 45°. Here coarse and fine sand alternate with each other and with layers of coarse and fine gravel. On either side at the edges the stratification is somewhat tumbled or disturbed. This is probably due to the melting away of the ice at the sides and the subsequent settling of this portion. The strata contain a few rounded pebbles of the Ohio Shale and neighboring limestones, but the great majority are of foreign rock. The sheet of till here caps these crumpled portions and even runs over the entire form.

At Eighteenth Avenue the curbstone of the street does not reach the bed rock in the cut, but it was said to have been struck some 4 or 5 feet deeper. The height of the esker above the curb is 11 feet. As the ridge turns sharply to the southwest at this point the exact width was hard to determine, but it was taken to be 115 feet. The strata are deposited in a more uniform arch over the center with less distortion on the edges. Deeper excavation, however, might show the edges to be distorted. The strata consist of alternate coarse sand and fine gravel. The whole is capped by till.

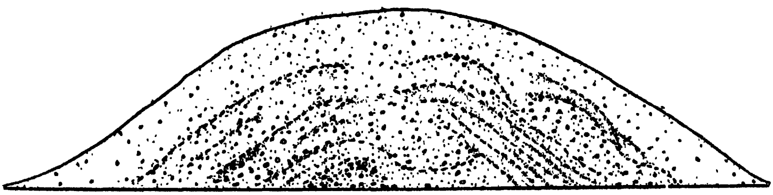

FIG. 5. A diagram to show the cross section on the north side of Sixteenth Avenue, width 114 feet, height (exposed) 13 feet, 5 inches.

The excavation for Sixteenth Avenue in the southern portion did not reach the bed rock (Figs. 5 and 6). Here it rises 13 feet, 5 inches above the cut and spreads out laterally to a width of 114 feet. The strata of the central portion are not laid down in such a uniform arch as those of the other two sections. Those of the eastern portion dipping at an angle of 45°. Fine and coarse sand and fine gravel alternate with each other. Water-worn pebbles of shale were found amongst those of foreign material. A few of those of the latter material attained the size of cobbles of 5 or 6 inches. Till covers the ridge as usual.

To the north and east of this ridge the plain is higher than to the west. Upon this higher ground the till is very thin if not almost entirely wanting. So sparse is it that it is hard to say where the till leaves off and the residual soil begins. Large bowlders or erratics, however, are sparsely strewn over the surface. Several large ones lie in Neil's Run immediately north of the ridge. One of these is about 6 by 8 feet. To the west and south the till, much of it stratified, increases very rapidly in thickness. The record of the State House Well shows it to be 123 feet ([8]), while another well drilled on the banks of the Olentangy River in the city limits passed through 104 feet of drift ([9]). Not only is the till much thicker but the large bowlders are much more numerous. These occur on the surface at frequent intervals and are smoothly worn.

FIG. 6. A portion of the cross section on the south side of Sixteenth Avenue.

Other instances of water-deposited glacial material occur within the city limits. The excavation for the present Chemistry Building on the State University Grounds, directly west of this esker, showed deposits of the finer water-assorted material. These occur in alternate strata of coarser and finer drift in which

8. G. S. O. Vol. I. Part I. pp. 113–114.
9. Ibid, Vol. VI. p. 282.

were troughs of non-conformable cross bedding. The latter were probably the work of small rivulets. Frequent excavations for other buildings adjacent to High Street often show this deposit of water-assorted glacial material. This sometimes is of a much coarser nature, large cobbles and bowlderets often forming the greater amount of the deposit. In South Columbus on the bluffs of the Scioto just off High Street fine examples of stratified drift occur. These are located well up in the drift.

In this part of the city there is also a gentle swelling of the drift to form a ridge-like formation, which reaches its culmination in Baker's Hill, 819 feet above tide. South of this other more or less distinct elevations occur until Spangler's Hill, 817 feet, is reached. Still further south a few indistinct knolls or short ridges occur. About opposite Duvall, in Pickaway County, a low ill-defined sand ridge gradually develops, which continues (at places almost wanting) for about a mile until the north end of the Circleville Esker is reached. This stands out some 40 or 50 feet above the surrounding country.

Are these level stratified deposits of the various parts of Columbus sand plain or alluvial fan deposits of the above glacial stream? Or are the knolls, short ridges and gravel hills, which lie between this Columbus Esker and the Circleville Esker, interrupted deposits of this glacial stream? Or is the Columbus Esker simply one of those short gravel ridges which cannot be definitely connected with a delta deposit or another esker system? Further field work and study alone can solve this, if a solution is possible, and this the writer hopes to be able to accomplish.

Practically ever since the abandonment of the ice-berg theory and the introduction of the glacial hypothesis for the origin of the till, Geologists have attributed eskers to fluvio-glacial action. Some have held that they were accumulated in supra-glacial streams. Some have argued this method together with englacial stream deposition. More, however, have attributed them to sub-glacial streams, while still others have favored all three methods in varying degrees. Opposed to the supra-glacial and en-glacial origin Chamberlin and Salisbury say that: "(1) So far as known, the surfaces of ice-sheets are free from drift (apart from wind-blown dust) except for a fraction (and generally a small one) of a mile from their edges; and (2) superficial streams are, in general, much too swift to allow of the accumulation of drift in their channels." [10]

Geikie also found strong arguments against the superficial stream deposit and concluded by saying: "The tendency of superficial water-flow would be rather to distribute morainic material (material upon the ice) in irregular sheets over the surface

10. Geology, Vol. III. p. 376, 1906.

of the ice than to arrange it in determinate linear courses, unless, indeed, we are to suppose that the superficial rivers succeeded in rapidly cutting their way down to the bottom of the ice-sheet, and thus at an early period formed deep trenches into which was shot all the rock-rubbish derived from the ice during its dissolution. If it be hard to conceive such conditions possible, it is not easier to see how river beds filled with detritus to a depth of 50 to 60 feet, more or less, could retain their position and sink gradually down during the general ablation of the ice sheet." ([11]).

Let us consider the only way of superficial water origin of eskers conceivable to Geikie, viz.: "deep trenches," that is, streams whose banks were the ice-sheets and whose bottoms were the ground. These streams with the vast amount of water and material cast into them would be nothing short of torrents and would carry the material along and deposit it in approximately longitudinal, horizontal strata. Now take a case of an esker of Maine, which passes beneath the water of a lake, up the side of a valley, over a col or divide of 200 to 400 feet, and thence down the other side. Here the stream (deep trench) would continue to lay down its load in practically horizontal layers until the top of the divide was reached. The result would be not a long comparatively uniform ridge, as we find, but a ridge of perhaps only a few inches in height at the divide and 200–400 feet in height in the valley and with a still greater height across the lake basin. The fact that we have these ridges of practically uniform height extending through lakes, up valleys, across divides and down into other valleys seems to point to but one origin, namely: sub-glacial streams flowing under "head" at the maximum extent or at the various stages of retreat of the ice-sheet.

The writer is under obligation to Dr. George D. Hubbard for many suggestions and criticisms and for the photograph for figure 6 and wishes to express his thanks to him for the courtesies extended.

11. The Great Ice Age, 3rd Edition, p. 174.

NOTES ON A SANDUSKY BAY SHRIMP, PALAEMONETES EXILIPES STIMPSON.*

WILLIAM B. HERMS.

During the summer of 1904 the writer secured several specimens of Palaemonetes for a brief morphological study. These specimens were taken in the waters of Sandusky Bay, Lake Erie, at what is called Black Channel. Before this time specimens had been brought into the Ohio State University Lake Laboratory at intervals, but in some seasons were difficult to secure. During the summer of 1905 not one was brought in. In August of 1906, at the close of the summer session the writer was collecting sponges near Black Channel, when two or three specimens were again unexpectedly taken. This led to a more extended search which resulted in the collection of many specimens, not only in Black Channel but also in the neighboring coves.

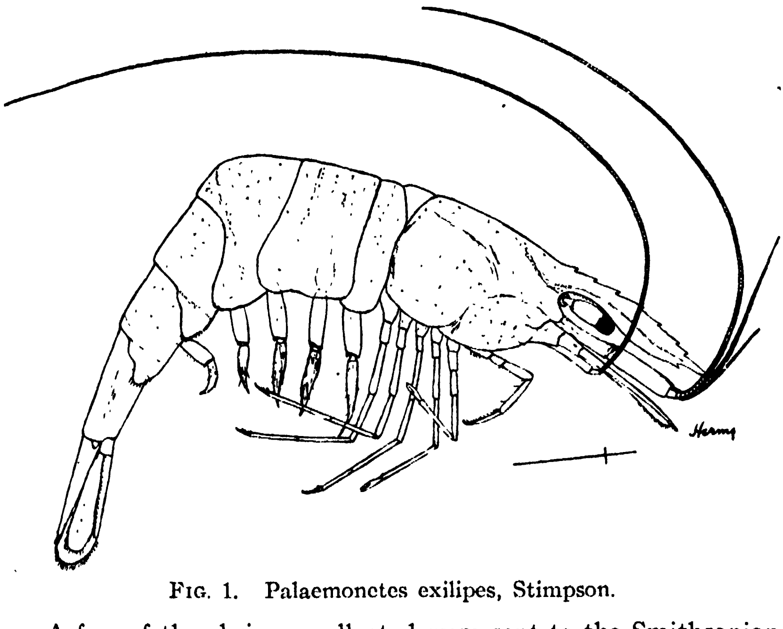

FIG. 1. Palaemonetes exilipes, Stimpson.

A few of the shrimps collected were sent to the Smithsonian Institution for identification. Miss Mary J. Rathbun, of the Division of Marine Invertebrates kindly identified them as Palaemonetes exilipes, Stimpson, widely distributed through the eastern half of the United States excepting New England. Miss Rathbun also stated that this shrimp grows to be two or three

* Read at the meeting of the Ohio Academy of Science, Dec. 1, 1906.

times the size of specimens sent in, which were about the average of those collected (22 mm. from tip of rostrum to tip of telson).

Besides being apparently rare in Sandusky Bay during past summers, another possible reason why shrimps have not been observed is the transparency of these individuals. They are almost as clear as the water in which they live, and if attention were not called to them, would probably pass notice. Specimens cannot be preserved, it seems, so that this natural transparency may be retained. Placing in alcohol (70 % to 80%) or formalin (4%) caused the specimens to become milky. Those dying naturally in the water also become milky. They can be cleared, however, fairly well in xylol.

The well developed springing power of the shrimp is a frequent cause for losing individuals. These characteristics, viz.: apparent scarcity, transparency, small size and springing power, make the collection of large numbers of shrimps difficult. With a small tow-net, never more than three or four were taken at a time, and frequently none.

This shrimp was first described by Stimpson in 1871 from specimens taken at Somerville, S. C. In 1872 ('73) Smith (S. I.) of the United States Fish Commission described the same species "from half a dozen specimens collected by Mr. J. W. Milner, at Ecorse, Mich., in a grassy arm of Sandusky Bay, Lake Erie, known as Black Channel." As Stimpson's specimens were from Somerville, S. C., and his description differed considerably from the Lake Erie specimens, Smith supposed, at the time his description was written, that the northern specimens represented a distinct species. This error was corrected when the latter received a series collected in the fresh water streams of Florida. Hay, in 1882, reports collecting this species in tributaries of the Tombigbee and Moxubee rivers in eastern Mississippi, in the Mississippi river at Memphis, in Pearl River at Jackson, and in the Chicasawha River at Enterprise, Miss. It is also reported by Forbes for Illinois: "Very common in Illinois River, where it is the only shrimp. Taken in large numbers at Pekin."

The extreme interest of this shrimp and the fact that little or no observations have been made on the behavior of the species, led the writer to observe it more closely.

Their usual habitat is clear, shallow water ranging in depth from one to perhaps four or five feet, with vegetation and sandy bottom. As soon as muddy or mucky conditions were encountered in towing, the shrimps were not to be found. The Sandy coves of Sandusky Bay, Lake Erie, abounding with vegetation, apparently afford ideal conditions and shrimps should be plentiful there. However, the carp and other fish are also plentiful and these undoubtedly feed on the delicate little shrimps. The

latter were found in greatest abundance two or three hundred feet from shore where the water was three or four feet deep. (The coves of Sandusky Bay are as a rule quite shallow). Towing near the surface was unsuccessful, a few were secured at the bottom, but most were taken midway, and somewhat nearer the bottom.

The most abundant vegetation in the coves of Sandusky Bay is included in the following list:

Myriophyllum spicatum L. (Very abundant).

Vallisneria spiralis L. (Very abundant.)

Ceratophyllum demersum L. (Abundant.)

Naias flexilis (Willd.) Rost & Schmidt. (Abundant.)

Philotria canadensis (Mx) Britt. (Water Weed.) (Very abundant.)

Potamogeton perfoliatus L. (Common; also five or six other species).

Pontederia cordata L. (Pickerel weed.)

Zizania aquatica L. (Wild Rice.)

Scirpus lacustris L. (Great Bulrush.)

Nymphaea advena Soland.

Castalia tuberosa (Paine) Greene.

Nelumbo lutea (Willd.) Pers.

Light Experiments.

On Aug. 17, 1906, thirteen shrimps were taken and at once placed in an aquarium two thirds full of water with a few pond-weeds and sand on the bottom. The aquarium was then taken into the dark room. Ten minutes after this it was examined with an acetylene gas lantern and the shrimps were found scattered. Holding the lamp for a moment at one end there was an immediate response, many swimming toward the light. The shrimps were then left in the dark for an hour.

2:46 P. M. Shrimps scattered. Within one minute five responded to the light, coming to the glass. (Light left in position).

2:55 P. M. Ten were at the light end, one within four inches and two at the farthest end. The movement toward the light was not a darting, but a gliding motion. When the glass was reached the motion was continued from side to side, but in one or two minutes the shrimps came to rest.

3:09 P. M. All seemed to be in about the same position.

4:15 P. M. The remaining shrimps were nearer the light. The light end of the aquarium at this time was fairly plastered with pond-snails which happened to be in the aquarium, eleven out of a possible fourteen had crawled up the glass.

4:45 P. M. Only two shrimps remained at the darker end.

6:00 P. M. The shrimps were pretty well scattered again. Those that could be observed had their heads turned away from

the light. An Agrionid larva had been clinging to the glass in front of the lamp for over fifteen minutes. (At this point the lamp was taken away.)

8:00 P. M. Examined again after the aquarium was in the dark for two hours. The shrimps had changed their positions, all but three or four having come to the surface of the water at the margin. On flashing a red light into the water through one end, two shrimps responded at once, the others did not change their positions.

(NOTE.—The aquarium used in the above experiment and the following ones measured 10 x 8 x 6 inches. The sides were covered inside with dense black cloth, ends open; a black focussing cloth served as a cover for the top and one end. An acetylene gas lantern, of bicycle pattern, was used for light, which in the above experiment was simply shed in at the open end. A good red light was secured by screening the face of the lantern with a cap of the best quality tissue paper. Far better results were obtained in the following experiments by cutting off all but a sharp well-defined path. When a full light is shed into the water through the open end of the aquarium, there is a response to the light, but because the water is lighted in comparatively so large an area, the response is rather undecided.)

During the following two days (Aug. 18–19) the aquarium was kept in daylight, *i. e.*, no experiments with artificial light were performed. The shrimps were quite inactive, clinging to the sides of the aquarium and seldom changing position. The darker corners were evidently preferred during the day. This was again apparent when the aquarium was covered with a focussing cloth and a path of sunlight was shed through an aperture in a pasteboard cover placed over one end.

Light experiments applied during the evening of the 19th resulted in no marked or ready response to the stimulus, though the light (artificial) was shed through a small aperture. This inactivity, I think, should be attributed to the fact that the shrimps were in a pathological condition because of the condition of the water, several clams having already died in it. The dragon-fly nymphs (four in number) on the other hand, darted for the light immediately and remained there for the evening excepting occasional excursions away from the light, this but for a moment, then to return and continue bumping against the glass and swimming back and forth from side to side of the light path. Several pond-snails also persisted in coming to the light even after having been pushed aside repeatedly; thigmotaxis, however, eventually carried them straight up the glass and away from the light.

On Aug. 26, 1906, twenty-six shrimps were placed in the aquarium after changing the water and other contents. There was an immediate rush to the light end (daylight), which was repeated again and again on turning the aquarium end for end.

At about 10:30 A. M. it was taken into the dark room, the light or open end being covered with a pasteboard cap having a V-shaped aperture 3–4 inch at the broad end and running to a point in 2 1–2 inches. In a few minutes (five or six), on hasty inspection, the shrimps were found to be scattered among the vegetation. White light shed through the aperture caused four or five shrimps to swim quickly to the light, others following in quick succession. Darkening the water again caused the shrimps to disperse. Red light, violet, blue, orange, indigo, green, and yellow, tried in above succession had a similar effect, *i. e.*, there was a more or less immediate response. There seemed to be a possible preference for red, which the writer has not been able to decide definitely. Colored light caused the shrimps to remain in the field of light better; this is probably due to the greater diffusion of the white light causing a broader and probably less definite field. The shrimps were in the dark room about two and a half hours, and during this time those nearest the light kept up a continual bumping against the glass. From sixteen to twenty shrimps were near the light with from four to twelve bumping the glass within the small area of light. Some seemed to rest on the sand at the bottom, while others kept up the bumping and vice versa.

Taking the aquarium so that sunlight might pass through the aperture now reduced to 3–4 by 3–4 inches, there was no response. The shrimps gradually went back to the pond-weeds or adhered to the sides of the aquarium, with none near the light.

At 7:30 P. M., of the same day (Aug. 26) the light experiments were again repeated, and the shrimps were found scattered throughout the aquarium, clinging principally to the pond-weeds. In two minutes with ordinary lamplight, twenty out of twenty-four (two of the twenty-six had died) were at the open end. Passing the acetylene gas light around the aquarium the shrimps followed it, with only a very faint light showing through the covered sides, making a complete circuit several times.

Using the 3–4 by 3–4 inch aperture again with red, violet, green, blue, orange, and yellow light, practically the same results were secured as above. A rest was given between the use of each color, during which time the shrimps invariably retreated to the pond-weeds. On flashing the light there was an immediate movement toward it, some individuals responding, however, more slowly. Each individual swam to and fro with head touching the glass. Several times it was observed that those which had gone too far into the dark corners, returned to the pond-weeds, but again came back to the light after coming once more in its wake, following a path as indicated by the arrows in the following figure.

With orange light at the aperture and fifteen to eighteen shrimps in the field, white light was placed at the opposite end, removing the orange light at the same time, three shrimps were at the other end (white light) in one minute, and eleven or twelve in five minutes. Changing back again to orange, five shrimps returned in one and one-half minutes and fourteen in five minutes. Experiments were continued in this manner for about an hour and a half with practically the same results, however, yellow light with which experiments were closed did not cause a ready response. This was probably due to the fact that the shrimps were suffering from fatigue, because yellow light used on fresher individuals had the same effect as any other light.

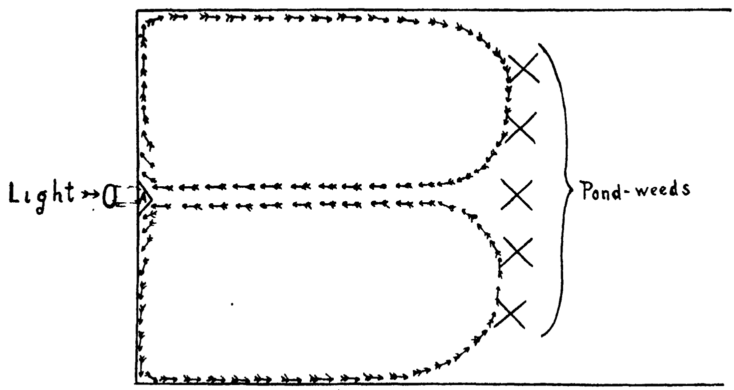

FIG. 2. Diagram showing course taken by some shrimps from pond-weeds to light shed through aperture A in covered end of aquarium. See text for explanation.

Later in the season two apertures were used of equal diameter, (about 3-4 by 3-4 inch), side by side, in the same pasteboard cap and about two inches apart. Two different colors were then used at the same time to test whether there was any preference. It was found by careful observation that there was no apparent choice, except as stated above, a possible preference for red.

(NOTE.—The screen used for colored light was made of the best quality tissue paper from one to three fold depending on the density. This paper was simply placed over the aperture in front of the acetylene gas lantern. The light thus obtained was good for all practical purposes, though great stress should not be placed on details, since the writer was not able to regulate carefully the intensity of the light so as to secure uniform results.)

CONCLUSIONS.—Palaemonetes exilipes Stimpson, is the common shrimp of Sandusky Bay, though not abundant. Shallow water with sandy bottom and rich in vegetation affords the most

favorable conditions. It is strongly, positively phototactic, not only to white light, but to red, green, violet, orange, blue and yellow, showing a probable preference for red.

OHIO WESLEYAN UNIVERSITY,
Delaware, Ohio, November, '06.

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ON THE OCCURRENCE OF PHYTOPHTHORA INFESTANS MONT. AND PLASMOPORA CUBENSIS (B. & C.) HUMPH. IN OHIO.*

A. D. SELBY.

The first named fungus, parasitic upon potato, *Phytophthora infestans* Mont., is a species of large economic importance, whose periodic epidemic outbreaks have become historic and have had far reaching economic and political effects. Most of you will recall the statements, that the potato rot resulting from this fungus, occurred in a virulent form in Eastern North America in 1842 and again in 1845—also in 1874. In 1845, and at later dates the disease spread to Great Britain, Ireland, Belgium and parts of Germany and France. In one earlier year, 1845, the greatest injury was done in Nova Scotia, New Brunswick and in Ireland.

This restatement of old facts is made to ask you to bear in mind the climate of the areas of greatest disease.

Doubtless most have heard of potato late blight and rot from this fungus and may be surprised to learn that it is of such rare occurrence in our state that not a single Ohio specimen of *Phytophthora infestans* is to be found in any of the herbaria of the country, save only a few collected at the Ohio Experiment Station within the last three years. However, I know that specimens were taken by the late Dr. E. W. Claypole, near Akron, O., in the early 80's, since I saw him once exhibit such material. This material was unfortunately destroyed in the fire

* Read at the meeting of the Ohio Academy of Sci.

which recently befell Buchtel College. In the preparation of this paper I have written to all the prominent herbaria and the laboratory of Vegetable Pathology, Washington. Michigan specimens are equally rare in Michigan, as are Illinois specimens in Illinois, so we are informed by those who know.

I may further state that from the writer's first connection with the Experiment Station in September, 1894, he was diligently striving to secure specimens of *Phytophthora* upon potato in Ohio, but did not succeed until August 1904, when it was collected in several counties. The fungus has reappeared and been collected in Northern Ohio each season since 1903, including that of 1906. The maximum injury to the potato crop was inflicted in 1905.

By the kindness of Mr. E. C. Green, of Medina, Ohio, I have been able to fix definitely the occurrence of *Phytophthora* in Granger township, Medina County, in 1883, thus confirming the Akron specimens destroyed by fire.

We are now prepared to ask, "What conditions determine the occurrence of outbreaks of *Phytophthora infestans* in Ohio?" —a questian which all will admit is more easily asked than answered.

Before undertaking to reply to such a question we may consider what conditions favor the propagation and development of this fungus, which so far as is known, is propagated by short-lived *conidia* or by the *mycelium*, the vegetable portion of the fungus; no oospores are known. Herein, we find some diversity of opinion among mycologists. Dr. W. G. Farlow * records that the potato rot due to *Phytophthora infestans* always occurs or begins about the first of August, that mositure is absolutely essential and that damp "muggy" weather is quite as favorable to its development as heavy rains. This applies more specifically to New England.

In this statement moisture is especially emphasized and properly so. Dr. B. D. Halsted † in his Mycological Notes of 1898 points out "A Close Relation between Rainfall and Potato Rot," in which he emphasizes the rainfall of 1889 (10.19) inches) and 1897 (11.42 inches); in both these years there were marked outbreaks of rot in New Jersey with none, or next to none, in intervening years, and states further: "It seems to me that *Phytophthora* or late blight is quite dependent upon an abundance of moisture in midsummer, and if this relation is noted sufficiently the time may come wehn it may be predicted with reasonably certainty, that a wet July will mean a decaying potato crop unless some successful method of checking tihs rapidly developing

* Bulletin of the Bussey Institution; I:320 (1875).

† Bull. Torr. Bot. Club XXV:160 (1898).

fungus is employed, and, contrariwise, a dry summer will insure freedom from its ravages."

Professor L. T. Jones * reports upon a favorable season for potato late blight in Vermont: "In 1902, the weather was remarkably cool and moist up to about August 1st, and it has continued cool and moist with more than the usual amount of rainfall since." That year we found the first *Phytophthora* July 13, "the earliest date in a dozen years' observations."

In 1903, Dr. Halsted † again reports serious outbreaks of rot in New Jersey, and mentions moisture as essential to this development of *Phytophthora* and states "A second favoring condition is warm weather—not hot or cold, but a condition of the atmosphere which obtains when there is a week or month of showery summer weather, often spoken of as close or "muggy"—just such as we have experienced throughout the state during August."

In this same connection Dr. Halsted gives the mean monthly temperatures and rainfall for New Jersey during the 15 years previous to 1903. These show for 1903 a June mean of 64.0° (-5.5°), July 73.3° (-0.6°) and August 68.4° (-3.9°) with rainfall about double the mean for June, normal for July and 2.32 inches in excess of normal for August. These conditions of 1903 followed a cool summer in 1902. Without closer analysis of these data we may now turn to other sources.

Scribner ‡ summarized the conditions favoring the disease as follows:

"1. Humidity—The years of great outbreaks have always been years of excessive humidity."

"2. A temperature ranging from 65° to 75° F.—a few degrese above 74° will check the development entirely, and down to 45° F. the fungus will continue to grow."

"3. Moisture in the soil—hence a clayey soil or one that will retain moisture is more favorable to rot."

While we may always need to keep in mind the distinction between *Phytophthora* rot, and certain other forms of rot, we may pass to a statement of Dr. Galloway's‖ "The rapid spread of the disease is dependent in a large measure upon ecrtain conditions of moisture and heat. A daily mean, or normal temperature of from 72° to 74° F. for any considerable time, accompanied by moist weather, furnisher the best conditions for the spread of the disease"; on the other hand, if the daily mean or normal temperature exceeds 77° F. for a few days the develop-

* Report Vermont Exp. Station: 15:210: (1902).

† Report New Jersey Exp. Station: 1903: 541–555.

‡ Report Section of Veg. Path., U. S. Dept. Agric. 1888: 338.

‖ Galloway, B. T.—Some destructive potato diseases—Farmer's Bull. 15: 1894: U. S Dept. Agric.

ment of the disease is checked. This explains why the potato blight fungus seldom occurs to any extent in sections where the mean or normal daily temperature exceeds for any length of time 77° F."

I am unable to state at this time the basis upon which the above statements rested at the time, but with certain modifications they will fully cover Ohio conditions. Recalling that the years 1883 to 1886 inclusive, and 1903 to 1906 in Ohio, were periods of prevalence for *Phytophthora infestans* in Ohio, we may glance at the weather conditions for these periods and compare with the means of the past 24 years. It seems only necessary to consider the months of June, July and August. Unfortunately our data do not extend back further than 1883.

I have prepared a table showing the mean summer temperatures and mean rainfall in Ohio for 1883 to 1906:

MEAN SUMMER TEMPERATURES AND RAINFALL IN OHIO 1883–1906

	Mean Temperatures.				Mean Rainfall.			
Year.	June.	July.	August	Season's Mean.	June.	July	August.	Season's Total.
					Inches	Inches	Inches	Inches
1883	69.0°	72.1°	68.2°	69.8°	4.25	4.16	1.88	10.29
1884	71.1	71.5	70.1	70.9	2.96	3.83	1.45	8.24
1885	67.1	75.2	68.9	70.4	4.34	3.20	6.33	13.87
1886	67.5	72.0	70.9	70.1	3.53	2.88	3.62	10.03
1887	71.0	77.9	77.9	75.6	3.85	2.16	2.39	8.40
1888	70.4	72.1	70.4	71.0	3.41	2.40	5.10	10.91
1889	66.7	72.5	69.1	69.4	4.13	4.25	1.50	9.88
1890	73.3	73.0	68.8	71.7	4.50	1.99	4.70	11.19
1891	71.0	69.0	70.0	70.0	4.82	3.82	3.07	11.71
1892	73.0	73.0	71.0	72.3	5.61	3.80	2.99	12.40
1893	70.6	74.5	70.7	71.9	3.34	2.49	2.17	8.00
1894	71.3	74.3	71.2	72.3	2.65	1.56	1.67	5.88
1895	72.0	71.6	73.5	72.4	2.47	2.00	2.96	7.43
1896	69.5	73.2	71.8	71.5	4.81	8.11	3.38	16.30
1897	68.1	75.5	69.4	71.0	2.85	4.65	2.72	10.22
1898	71.9	70.0	73.5	71.8	2.86	3.98	4.50	11.34
1899	71.5	74.1	73.7	73.1	2.96	4.18	1.82	8.96
1900	69.8	74.1	76.3	73.4	2.99	4.62	3.68	11.29
1901	70.9	78.1	73.1	74.0	4.38	2.73	3.32	10.43
1902	66.9	74.0	67.4	69.4	7.48	4.69	1.67	13.84
1903	64.4	72.9	70.7	69.3	3.97	3.67	3.20	10.84
1904	68.4	71.4	68.8	69.5	2.88	4.13	2.74	9.75
1905	69.2	73.0	71.7	71.3	4.72	3.93	4.46	13.11
1906	69.8	72.1	74.6	72.2	3.41	5.14	4.72	13.27
Ohio...	69.7°	73.9°	71.5°	71.7°	3.94	3.97	3.04	10.95

The summer temperatures for the years 1883 to 1886, taken as a whole, were decidedly below the normal. The same is true for the summer months for the years 1902 to 1906, excepting the month of August 1906.

The data at hand indicate that when we have cyclar periods of low summer temperatures we may anticipate one or more seasons of *Phytophthora* outbreaks. A single season, or a single month scarcely controls; abundant moisture alone may not determine, as is shown in contrasting the years 1905 and 1906 in Ohio. In 1905 the July rainfall was 3.93 inches; that for August 4.46 inches, while in 1906 the July rainfall was greater, 5.14 inches, and that for August 4.72 inches; however, in 1906 the August temperatures rose above the optimum, the mean being 74.6° F.

It will be well at all times to bear in mind that hot and cold are relative terms; our mean summer climate is above the optimum for *Phytophthora infestans*—so that in Ohio the seasons that are below normal are the ones which favor the fungus. In Maine, Nova Scotia, New Brunswick and Ireland, this may not be relatively the case. The mean summer isotherm of 70° F. crosses Northeastern Ohio, in an irregular line, entering the state in southern Columbiana county and emerging at Vermillion Erie County; a second area in northwestern Ohio is crossed by the same isotherm. The southern area of the state is excluded from the *Phytophthora* areas by the higher temperatures, as well as by the early potato crop grown there. It may be mentioned in passing, that very early potatoes in Georgia and Florida are also attacked by *Phytophthora.*

From other known considerations, the foregoing suggestions do not appear unreasonable. The potato plant is native in cool regions and is most successfully cultivated in the cooler portions of Ohio and in states of more northerly latitude. That the development of the parasitic *Phytophthora* should be favored by analagous conditions even though limited by a much narrower range of temperature and rainfall than the host itself, can scarcely be regarded as strange. The irregularity of the outbreaks of *Phytophthora* in Ohio, is an economic difficulty in its control, since the public mind acts only after the fact. For Ohio it seems not improbable to the writer, that a succession of favorable or cool seasons leads to the gradual southward advance of *Phytophthora*, until established within our area; we then have one or more violent outbreaks of disease, followed in turn by the gardual disappearance of the fungus during a cycle of hot or dry seasons, or both hot and dry seasons. It seems very evident that we do not always have it with us.

CONCERNING *Plasmopora Cubensis.*

This second fungus, *Plasmopora Cubensis* (B. & C.) Humph., parasitic upon the cucumber, *Cucumis sativa*, and upon other cultivated and wild species of *Cucurbitaceae*, offers a contrasting history of development. There is a brief history given in Bulle-

tin 89 O. Agric. Exp. Station, published by the writer in 1897, and is as follows:

"The history of this trouble is not an extended one, yet its restatement may help in later considerations. The fungus was first described in 1868, by Berkely and Curtis,[6] from specimens on a wild plant from Cuba. It was at the time called *Peronospora Cubensis.* In 1888 the same fungus was found upon cucumbers in Japan[7]. Meanwhile, before this fact had been published, that is in 1889. Dr. Halsted, of New Jersey, had found the fungus upon hot-bed cucumbers at New Brunswick.[8] He then expressed the fear that "Market gardeners may have in the cucumber mildew a serious enemy, especially should it spread to squashes, melons, and other members of the *Cucurbitaceæ*, annd attack the seedling plants." It was afterwards found by him upon cucumbers, squashes and pumpkins in various parts of the State.[9] The same year it was reported by Professor Galloway[10] from Anona, Fla., and College Station, Texas. Humphrey[11] reported it from Massachusetts, for 1890, upon garden cucumbers and squashes. He changed the name to *Plasmopara Cubensis* (B. & C.) Humph., since it was found to belong to that genus. In 1891 it was again reported by Dr. Halsted[12] who found it almost everywhere about New Brunswick, though it had not been observed in 1890. Watermelons were attacked by it both there and at New Haven, Conn. The same disease was again prevalent in New Jersey in 1892 and in 1893. About this time it began to be destructive to field cucumbers in south-eastern New York[13], where it continues to be prevalent and destructive to the present time. In 1895, the same trouble appeared in forcing houses in Ohio and in the writer.s garden at Wooster[14], but did not prove serious.

In 1896, it was very destructive in forcing houses at Hyde Park, and while not reported or studied, so far as known, in the pickle fields of Ohio and Kentucky, where the disease proved so injurious in 1897, there are some evidences, chiefly later inferences from observations made at the time by growers, that the downy mildew prevailed to a more limited extent in 1896."

This subtropical species reproduces itself by short-lived *conidia* which germinate by swarm spores; no oospores are

6. Journal Linnæan Society, Botany, x, 363.
7. Farlow, W. G. Botanical Gazette xiv, 189.
8. Botanical Gazette, xiv, 152-153.
9. Journal Mycology, v. 201.
10. Journal Mycology, v. 216.
11. Eighth Annual Report Mass. State Ag'l Exp't Station, 210–12.
12. Report Botanist N. J. Exp't Station, 1891, p. 248. See also Report Conn. Exp't Station 1891, p. 97.
13. Stewart loc. cit., p. 155.
14. Bulletin 73, pp. 231–4.

known. Observations made by the writer during the years 1895 to 1906 inclusive, show that this *Plasmopora* makes its appearance upon field *cucurbits* in northern Ohio very much earlier in a warm season than in a cold one; it has never been collected earlier than August 10th in the vicinity of Wooster (August 3rd, Marietta, O.) and it is sometimes as late as Sept. 10th, and, possibly, altogether absent. The cool seasons of 1902–1905 have brought very late or no development of *Plasmopora* in Ohio, while the warm August of 1906 witnessed an early development near Wooster, August 11–14. These dates but repeat those of 1898 and 1897. While the optimum temperatures of *Plasmopora Cubensis* are not specifically known to me, these are probably near the summer maximum in Ohio. Seeking to get fuller data upon the occurrence of this fungus in the United States, the writer through the co-operation of Dr. T. B. Galloway, U. S. Department of Agriculture, mailed letters of inquiry to most mycologists and pathologists of the United States in 1898. The replies elicited the fact from Prof. H. H. Hume that the *Plasmopora* evidently survives the winter upon wild *cucurbits* in Florida and from other data, the same appears at successively later dates northward as the season advances. At that time the writer suggested the possibility that the *Plasmopora* upon cucurbits is propagated northward each season by means of its *conidia*; a possibility that may now be regarded as a probability. In addition to this the disease is occasionally domiciled in forcing houses and there survives. May this northward advance each year, like that of migrating birds, be the true explanation of its recurrence with us? The matter is difficult of proof but yet scarcely improbable.

SOME NOTES ON COLLECTING MOLLUSCA IN OHIO DURING 1906.*

V. STERKI.

The summer of 1906 was not favorable for collecting mollusca in rivers and creeks. The water was higher and more turbid than it usually is. The same has been reported from other states. Yet there was some good in this state of things; on the one hand, the mussels and snails had a favorable season for growth, and on the other, they were somewhat protected from the shell and pearl hunters.

A few, somewhat hurried, collecting trips were made to some parts of the state; the expenses of most of them were paid from the McMillin fund of the Ohio State Academy of Science. The results of these trips were somewhat below expectations, partly on account of the conditions of the water and weather; as for some of them the season was too much advanced. Yet, a few species were found which had not yet been listed for the state, and many localities were noted. The finding of a fossiliferous deposit in Defiance County was also of interest. Like the similar deposits in the Ohio and Miami Valleys it shows that there was a time when land snails especially were plentiful. Compared with this, our present molluscan fauna is very poor, especially in the northwestern part of the state.

On the whole stretch from the western parts of Stark and Summit counties to Defiance, there are few places where land snails can find "congenial surroundings," even approximately suitable conditions of life, in consequence of deforestation, drainage and culture of the soil. It is evident that not only the number of individuals is diminished to a small per cent of their numbers even of a few score years ago, but that many species are being exterminated over large tracts of land. And the same can be said, to a large extent, of fresh-water mollusca, gastropods as well as bivalves.

It is generally understood that limestone is favorable for the growth of snails; but at Tiffin, e. g., I was badly disappointed. A several hours' tramp left my boxes almost empty, and apparently favorable and promising places were found absolutely barren. But the rocky rapids of the Sandusky river yielded a few things which had not been looked for—although no Unionidae— and show that at favorable places of that river a rather rich harvest may still be expected.

The Licking River (or creek) at Newark is very poor; a few snails were found, but not a trace of a mussel. Yet there is no doubt that it had its fair share of them. Rather the same con-

* Presented at the meeting of the Ohio State Academy of Science.

dition is coming on in the Great Miami river, where I was collecting a few years ago at and above e. g., Hamilton, also at Dayton. The very wide river bed is in striking contrast to the little shallow stream at low water. The few species of Unionidae still there, and few in numbers, are of large forms and show that the river must have offered very favorable conditions for their development. But very few young and half grown specimens were found; before very long, most or all of them will be gone; and the shell and pearl hunters are hastening their extermination.

A few words may be added with respect to Lake Erie. Unfortunately, I have had no chacne yet to do systematic and thorough collecting in the lake itself with the dredge. But repeated collecting along the shore, at Sandusky and Vermilion showed that there is still a fair number of Unionidae. Pleuroceridae, etc. A strange contrast to this is seen, e. g., at Fairport, Lake County. All I was able to find there was a dead shell of *Lampsilis luteolus*, not a trace of anything else, in spite of all search east and west of the Grand River, along the lake. And that was a few days after one of the severest storms of the season. A man coming along the beach held a water-worn Pleurocera in his hand, as a rare find; and a fisherman who has lived there for the last thirty years told me that he knew of no place where I might find a mussel. Probably the same condition as that of mollusa is found with respect to other groups of animals. What is the cause of such utter barrenness? And how is it with other parts of the lake, further eastward?

It may be repeated that it is high time to take an inventory of our mollusca fanna, that some more systematic collecting be done in various parts of the state which are still as much as unexplored. Students of nature are urgently invited to pay their attention to these interesting animals. A pamphlet giving directions for collecting and preparing specimens will be published by the Carnegie Museum. Correspondence with anybody interested—or to be interested—in this line, is solicited.

New Philadelphia, Ohio.

MEETING OF THE BIOLOGICAL CLUB.

The meeting was called to order by the president, Mr. Hambleton. The minutes of the previous meeting were read and approved.

The paper of the evening was by Prof. Graham, his subject being "Practical Nature Study."

In the discussion which followed, the following members took part, J. H. Schaffner, E. D. Ball, J. S. Hine and H. Osborn.

It was moved and seconded that the Editor and the Business Manager be appointed a committee to confer with the librarian with a view to presenting the exchanges of the OHIO NATURALIST to the library; the library to have them bound. The motion was carried.

The following were elected to membership: Grace T. Earle, Nelle Ely, Edgar Hirst, Julio Ortega, A. W. Castle, L. M. Steckel and W. Selby. The club then adjourned.

J. N. FRANK, *Secretary.*

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CYMATHERE, A KELP FROM THE WESTERN COAST.*

ROBERT F. GRIGGS.

Cymathere is a genus of the Laminariaceae established by J. G. Agardh '67 to receive the older *Laminaria triplicata* of Postels and Ruprecht '40. Though De Toni '95 includes in it *Laminaria crassifolia* which has a branching holdfast, the genus is monotypic. Its sole species, *Cymathere triplicata*, is confined to the northern portion of the Pacific Ocean. It grows abundantly at the Minnesota Seaside Station on Vancouver's Island where the plants herein described were collected.

In its habitat Cymathere is the antithesis of such kelps as Postelsia and Lessoniopsis. Far from seeking the buffets of the surf, it retires into secluded nooks where the surge of the waves is no more than a gentle swishing to and fro. It does not succeed well except in situations which are never uncovered by the tides. On this account the juvenile forms are difficult to obtain by the more usual methods of collecting. Those gathered by the writer were secured by picking out of a pothole, in which the adult plants were flourishing, a number of stones as large as could be lifted easily. Search of these with a hand lens at leisure in the laboratory disclosed plants of all ages, down to the smallest obtained.

At its maximum size the narrow oblong lamina of Cymathere may reach a length of 4 meters and a breadth of 22 cm. No single specimen was seen, however, in which both these extreme dimensions were present. Most of the plants are quite narrow, only about half as wide as the broadest, which are very short with plicae very much broadened and less prominent than in narrower individuals. The base is cunate or rounded, narrower in young specimens and broadening afterwards as Yendo '03 has shown to be the case in *Hirome undarioides*. At the tip

* Contributions from the Botanical Laboratory of the Ohio State University, XXIX.

the plicae are the last p[illegible]ions to be eroded away and hence they frequently stand out [illegible] long acuminations beyond the blade proper. The stipe is [illegible]ingly short for so large a plant, seldom if ever exceedir[illegible] The holdfast has no hapteres rising from the stipe but [illegible]onsists simply of the primitive disc, which becomes about 3 cm. in diameter covering thus a very much smaller area than the holdfast of those kelps which have a number of hapteres to increase the strength of their hold on the rocks. As in Renfrewia the surface of the primitive disc (not the stipe above) is subject to local secondary growth by which means branches are formed which pass outward and strengthen the holdfast. These are, however, so flat and so closely appressed to the disc that they are not noticeable except in sections, (See figure of Renfrewia, Postelsia 1906: Pl. 18.)

Specimens in fruit are not easy to find at Port Renfrew during the summer season. Late in the season, however, in old plants may be found at the base of the lamina on both sides, the lanceolate fruiting patches. Proximally they may extend to within a millimeter of the base of the lamina following its margin around till its full width is attained at which point they suddenly narrow to the plicae up which they extend for a distance of about 25 cm., making the whole sorus 40–50 cm. long. At its tip the fructiferous area extends much further up in the grooves than on the ridges of the plicae, thus forming on one side three and on the other two or four acuminate points 5–25 cm. long.

It will be of interest to compare the positions of the sori in Cymathere and such kelps as Nereocystis. In the latter the gonidia are born out near the tips of the branches perhaps a hundred feet from the attachment of the holdfast. Instead of maturing in one definite short season as seems most likely to be the case with Cymathere, they are borne continuously from the time the plant becomes mature till it is torn up by the waves. When liberated the zoospores must be carried long distances by the waves, in addition to the space they traverse by their own activity, before they settle down to the substratum. But in Cymathere, growing in relatively quiet water, they are set free within a few inches of the station of the parent plant and might be expected to settle close around it. The habit of the one would be most favorable for wide dispersal but only a very small proportion of the reproductive bodies would succeed in establishing themselves in favorable situations. The other would be slower in dispersing itself but a larger percentage of the spores would start favorably. These inferences are well borne out by the facts of the distribution of the young of the two species. Nereocystis, it will be recalled, thrives only in the deep water off shore where it is able to reach the surface with its long stipe. But on

a coast where it is well developed its young plants may be seen everywhere between the tide marks ...en up as high as any of the kelps grow, where they mus... perish because of the unsuitable conditions. They are ...he most abundant of all the young kelps to be found ev... ...gh levels. The young of Cymathere though it grows much closer to the tideline than Nereocystis, are not often found growing uncovered a...low water and are very much less abundant though the adults are by no means scarce at Port Renfrew.

In its histology Cymathere offers some points of interest. As to the presence or absence of mucilage ducts there seems to be some question since De Toni '95 contradicts Kjellman '93 by asserting that they are present. In the specimens which I have examined the stipe is wholly without ducts of any kind, while in the lamina there occurs an irregular circle of openings which may be considered mucilage ducts. But they are not definitely developed tubules with a lining wall of special secreting cells as MacMillan '99 reports in Nereocystis; nor are they in a closely crowded circle of definite position as in *Laminaria bongardiana* or in *L. bullata* as figured by Miss Mueller '04, fig. 8. They appear rather as a local gelatinization and breaking down of certain cells, perhaps the beginning of degeneration. To the writer it seems most likely that their presence or absence is a very variable character which might not appear in younger,more vigorous material. This if true would explain the disagreement of the authorities cited. A similar breaking down of certain cells may sometimes occur in *Renfrewia parvula* but very much less abundantly. In this case I did not consider the cavities thus formed mucilage ducts because they seemed simply pathological alterations of the tissues and not normal occurrences.

In places the inner cortex is developed into thick walled strengthening tissue as is usual in the family. It is of such sclerenchyma that the ribs on the folds are formed and to it they owe their strength. The greater thickness of the ribs beyond that of the rest of the lamina is entirely due to the extra development of this tissue.

The development of the sporangia follows closely that of other kelps. MacMillan's '99 figures of the early stages of their development in Nereocystis might almost bave been drawn from my own preparations of Cymathere. The separation of the pellicle from the sorus takes place after the following fashion: The outer cell walls of the epidermis of the unaltered lamina form a rather thick cuticle over the surface. When the epidermis divides into the two layers which go to form the paraphyses and the sporangia, the daughter cells secrete for themselves new cell walls, at least on the external and lateral faces, leaving the old cuticle with the partitions between the cells, free and hanging to the lamina only by the bases of the latter. On the elongation of the paraphyses these connections are broken and the

pellicle is sloughed off. As in other kelps the sporangia do not develop simultaneously but one finds on sectioning a fruiting lamina (fig. 1 *a*), by the side of those which are nearly mature, many others much shorter and younger. The paraphyses, in the material studied, do not conform to the usual type in the Laminariaceae and instead of being clavate with heavy gelatinous tips are linear and without any thickening of the wall at the tip. Their chloroplasts are localized at a point a little back from the colorless tip forming a definite brown stratum above the tops of the sporangia. The discovery of such a character in Cymathere is somewhat of a surprise for it was expected that the genus was like Laminaria in this respect, a fact which lead Kjellman '93 to ascribe to it in his key, the usual clavate paraphyses.

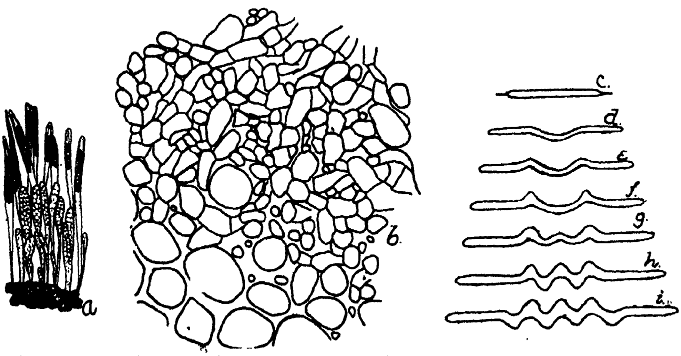

FIG. 1. *a.* Camera drawing of a portion of a fruiting lamina, showing sporangia and paraphyses. X 110. *b.* Camera drawing of a portion of a cross section of a stipe showing pith web and sclerenchyma. X 110. *e–i.* Diagramatic cross sections of the lamina to show the development of the plicae.

In respect to the development of the pithweb Cymathere shows a great resemblance to *Renfrewia parvula*, contrasting strongly with the Laminarias as exemplified by *L. bongardiana.* The hyphal elements are very short, composed of short cells. Trumpet hyphae are very scarce and poorly developed (fig. 1 *b*). In this respect this genus is very much less highly developed than most of the Laminariaceae.

The smallest specimen (fig. 2) of Cymathere found measures about 2 mm. in length. The identification of specimens of this size is, however, somewhat uncertain for I know no character to differentiate them from other kelps when so young. In this specimen the lamina is plane, only one cell in thickness, and oval in shape. The stipe is about half as long as the lamina and several cells thick; in its centre can be seen with a hand lens a faint narrow longitudinal streak composed of longer cells which probably become the pith web. The holdfast of course is the primitive disc.

The smallest specimen which could be certainly identified was about 7 mm. long (fig. 4). In this the stipe was only very slightly longer than in the smaller specimen, being still less than a millimeter while the lamina had become much longer. From this period on through life the species is characterized by a long narrow lamina on a very short stipe. In the center of the lamina has appeared a band of tissue several cells in thickness, which extends from the transition region, where it narrows into the stipe, in an oblong patch through the middle of the blade to within about 2 mm. of the tip.

This thicker area soon cuts oft and separates the original thinner portion from the growing point in the transition region and pushes it out into the end of the lamina. This action does not, however, as might be supposed, presage the speedy disappearance of the primitive thin region. On the contrary it shows itself able to make good the waste of erosion for a long time and even increases very much in size. At the first appearance of the thicker band its area is only about 6 sq. mm. while in a specimen about 5 cm. long (fig. 8) it covers 180 sq. mm. forming a wide ruffle all around the tip of the lamina. It continues to be found on specimens even longer than 200 mm. (225 is the longest of such in my collection) but greatly eroded though still giving evidence of continued growth. The presence of a lamina one cell in thickness has been noticed by Setchell '05 who gives a summary of the cases in which it is known to occur. These are *Laminaria saccharina*, *Saccorhiza dermatodea* (Setchell '91) and *Alaria esculenta* all of which Setchell himself has seen, though the case of Laminaria was earlier described by Reinke and perhaps by Kuetzing whose determination, however, Setchell questions. From these cases Setchell infers that such a stage is common to all of the Laminariaceae. Though not so described by MacMillan '99, Nereocystis has the same manner of growth. The writer has in his collection a plant 4 cm. in length in which the pneumatocyst is just beginning to show as a darkened area slightly different to the touch, and a very faint short depression already marks the beginning of the first split. In this specimen there is a margin extending around the tip and half way down the blade about 1 mm. wide, of thin tissue exactly as in Cymathere. In Saccorhiza as figured by Setchell '91, the primitive blade persists only till the plant is about 7 cm. long. I am indebted to Professor Setchell for the information that nearly all the plants from the northwest coast labelled by Harvey *Alaria marginata* are young specimens of Cymathere, a designation which may well have been suggested by the long persisting remannts of the embryonic lamina. All this would indicate that the large size attained by the one layered lamina in Cymathere is quite exceptional.

The first indication ... the folding characteristic of the genus appear in a specimen ... m ... long. The exact manner of the folding can not be ... out at first but in a specimen a little larger, where ... tended, it is seen to consist of a faint downward be... groove in the middle of the lamina (fig 1 *d*) By e... little beyond the plane of the lamina, at its ... next originates beside it two lateral ridges ... st faint, these are soon made prominent by the ... formation of sclerenchyma along their length (... 9). In specimens about 20 cm. long the first indications of the third ridge begin to appear in the flattening and finally in the bending upward of the middle of the original median groove (fig. 1 *g*). This appears most prominently in the middle of the lamina and fades out both toward the tip and base, a condition which obtains even in specimens half a meter long, in which the third ridge does not attain its full development for a distance of 10 cm. from the base; and even in large specimens the two lateral ridges may extend closer to the base than does the central. Gradually, however, it also extends downward till this indication of its later origin is lost. Meanwhile this ridge is thickened and strengthened (fig. 1 *h*) as were the first two; and the grooves between it and the lateral ridges have given rise to two more ridges on the reverse side of the lamina which are in turn similarly thickened. Just as the edges of the first groove made the two lateral ridges, so the edges of these may bend down beyond the plane of the lamina forming on the reverse side two additional ridges which may be thickened (fig. 1 *i*) so that the lamina has sometimes three and four ribs instead of three and two. This condition I have seen only in a very old specimen toward the base; at the tip the extra ribs faded out showing in the process all transitions and clearly indicating the manner of their formation.

This study would seem to show that Cymathere is not like Pleurophycus, as might have been supposed, probably a derivative of the Laminarias by the development of the folds in the lamina. Its simple holdfast seems to be the external indication of a structure in all respects simple and low in the scale, though not necessarily primitive. Its linear unthickened paraphyses together with the poor development of mucilage ducts and pith-web would indicate that like Saccorhiza and Phyllaria it probably branched off from the main phylum of the Laminariaceae before the habit of producing clavate thickened paraphyses and a holdfast of secondary hapteres became ineradicably fixed as it is in the higher kelps. In its development nothing noteworthy was found except the very long persistance and large size of the primary one-layered lamina, a character, the significance of which in the phylogeny, I am not prepared at this time to estimate.

GRIGGS on "Cymathere."

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EXPLANATION OF PLATE VII.

Photographs of juvenile forms of Cymathere triplicata taken by transmitted light. Figures 2–8 about three times natural size brightened in places with a pencil to bring out the contrast. Figure 9 natural size also slightly retouched.

Fig. 2. The smallest specimen found.

Fig. 3. The largest before the appearance of the adult lamina

Fig. 4. The first appearance of the several layered lamina.

Figs. 5–8. Progressive series up to the beginning of the folding which has just commended in fig. 8.

Fig. 9. A specimen showing the two ribbed condition; the original groove between them has not yet begun to flatten to form the third ridge; at the tip are the remnants of the embryonic lamina.

THE EMBRYOLOGY OF SAGITTARIA LANCIFOLIA L.

MEL. T. COOK.

We have been accustomed to base our ideas of the close or distant relationship of species, genera and families on external characters but some of the recent literature on embryological subjects has indicated that the life histories and development of species which are apparently closely related may be quite different. Johnson* calls attention to the wide variations that occur in the development of the tapetum, megaspore, embryo-sac and endosperm in the genera of a single family. In my recent paper on the Cuban *Nymphæaceæ*† I called attention not only to the difference in character of the endosperm but also to differences in the development of the embryos. This difference was especially interesting in the case of our northern *Nymphæa advena* and the Cuban *Nymphæa* which is either a different species or a variety, although the external differences are by no means conspicuous. In the light of these recent investigations it becomes interesting to know to what extent we may expect these differences in the internal life history of the more or less closely related species and also to know whether these differences co-ordinate with the external differences. This presents the questions: Are embryonic characters valuable in the separation of species? Are they of phylogenetic importance?

Recently the author accepted an opportunity to make a study of *Sagittaria lancifolia* L. for the purpose of comparison with *S. variabilis* Engelm. (now known as *S. latifolia* Willd.) as studied by Schaffner‡.

Sagittaria variabilis is distributed throughout the greater part of North America except the extreme north and extends to Mexico and Florida, while *S. lancifolia* is distributed from Delaware southward and throughout the West Indies. The two species overlap in geographical distribution in the southern part of the north temperate zone; *S. variabilis* extending much farther north and *S. lancifolia* much farther south. Externally these two species present very striking differences especially in character of the leaves and fruit as shown by the following comparison:

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*Johnson, D. S.—Seed Development in the Piperaceæ and its bearing on the Order. Johns Hopkins Univ., Cir. 178. 29–32. 1905.

† The Embryology of some Cuban Nymphæaceæ. Botanical Gazette, 42: 376–392.

‡ Schaffner, J. H.—Contribution to the Life History of Sagittaria variabilis. Botanical Gazette 23: 252–273, 1897.

SAGITTARIA VARIABILIS.	SAGITTARIA LANCIFOLIA.
1. Monoecious or sometimes dioecious.	Monoecious.
2. Leaves sagittate, variable in form and size, sometimes broader than long, 15–40 cm. long, basal lobes, ovate or lanceolate, acute or acuminate.	Leaves not variable, 4–9 dm. long; leathery, broadly linear or elliptic, acute.
3 Scapes 3-6 dm. long, angled, simple or branched.	3. Scapes 6–20 dm. long, simple or branched.
4. Filaments not dilated, glabrous.	4. Filaments not dilated, pubescent.
5. Mature heads 1.5-3 cm. in diameter.	5. Mature heads 1 cm. in diameter.
6. Bracts 1.5 cm. long, glabrous, acute or acuminate.	6. Bracts ovate or ovate-lanceolate, 1–2.5 cm. long, acute or acuminate.
7. Flowers 1.5-2.5 cm. broad.	7. Flowers 1–2.5 cm. broad.
8. Achenes obovate, about 2–4 mm. long, erect, undulate winged; beak ascending or recurved.	8. Achenes cuneate or obovate, 2–3 mm. long, winged; beak short, ascending.
9. Summer and fall.	9. Spring and summer.

With such striking external differences one would naturally expect equally interesting internal differences but to my surprise I found the development of the embryo-sac and embryo of *S. lancifolia* practically the same as had been described by Schaffner for *S. variabilis.* The comparison with Schaffner's results will be brought out in the following discussion.

EMBRYO-SAC.

The author was unable to determine the origin and development of the archesporium satisfactorily but traced without difficulty, the deveropment of the embryo-sac beginning with the one-nucleate stage (Fig. I). In the formation of the two-nucleate (Fig. 2) stage the sac elongates to twice the length of the one-nucleate stage. Schaffner did not secure material for these two stages but from this point on the development of the embryo-sac of the two species is exactly the same, except that I was inclined to believe the antipodals in *S. lanceolata* not quite so presistent as he found them in *S. variabilis.*

ENDOSPERM.

The development of the endosperm follows exactly the same course as that of *S. variabilis* as described by Schaffner. Schaffner did not fully understand the significance of the lower endosperm

nucleus but advanced the idea that it might "play an important part in the transfer of food material from the funicular region, beyond the antipodals, to the cotyledons, and especially in facilitating the formation of the cap of endosperm which covers the tip of the cotyledon." This idea has been supported by my papers on the *Nymphæaceæ** in which I found similar structures and by Ikeda†, who demonstrated the antipodals to be in the course of the food supply in certain species of *Liliaceæ*. In *S. lancifolia* I find further evidence in favor of this view, in many instances the antipodals disappear and this part of the sac is extended into a pocket-like structure (Fig. 3) in which we find a mass of protoplasm extending to the lower endosperm cell. At this time the embryo (Fig. 17) was well advanced.

EMBRYO.

Although the author did not secure the very youngest stages of the embryo, after examining a large number, it seemed evident that the embryo had followed exactly the same line of development as the embryo of *S. variabilis*. The elongation of the embryo was due to the repeated division of the cell next to the suspensor. By the time four cells in addition to the large suspensor cell had been formed, the apical cell divided by the formation of a longitudinal wall (Figs. 5, 6). After this the longitudinal divisions were found to be somewhat irregular (Figs. 7 to 16). The longitudinal cell walls were frequently very indistinct but the number of cells could be ascertained by counting the nuclei of the serial sections. My material was unsatisfactory for making a study of the more advanced stages of the embryo but it apparently followed the same course of development as *S. variabilis*.

From the facts herein presented it appears that the internal and external characters do not necessarily co-ordinate. In the case of *Nymphæa advena* of the north and the *Nymphæa* ——— of Cuba which so far as external characters are concerned are strikingly similar the embryos show considerable differences, while in the case of *S. variabilis* and *S. lancifolia* the external characters are strikingly different and the embryological characters are practically the same. But we are now confronted by a new question which can only be answered by future investigations: Are the embryological characters of the plant more or less plastic than the external characters?

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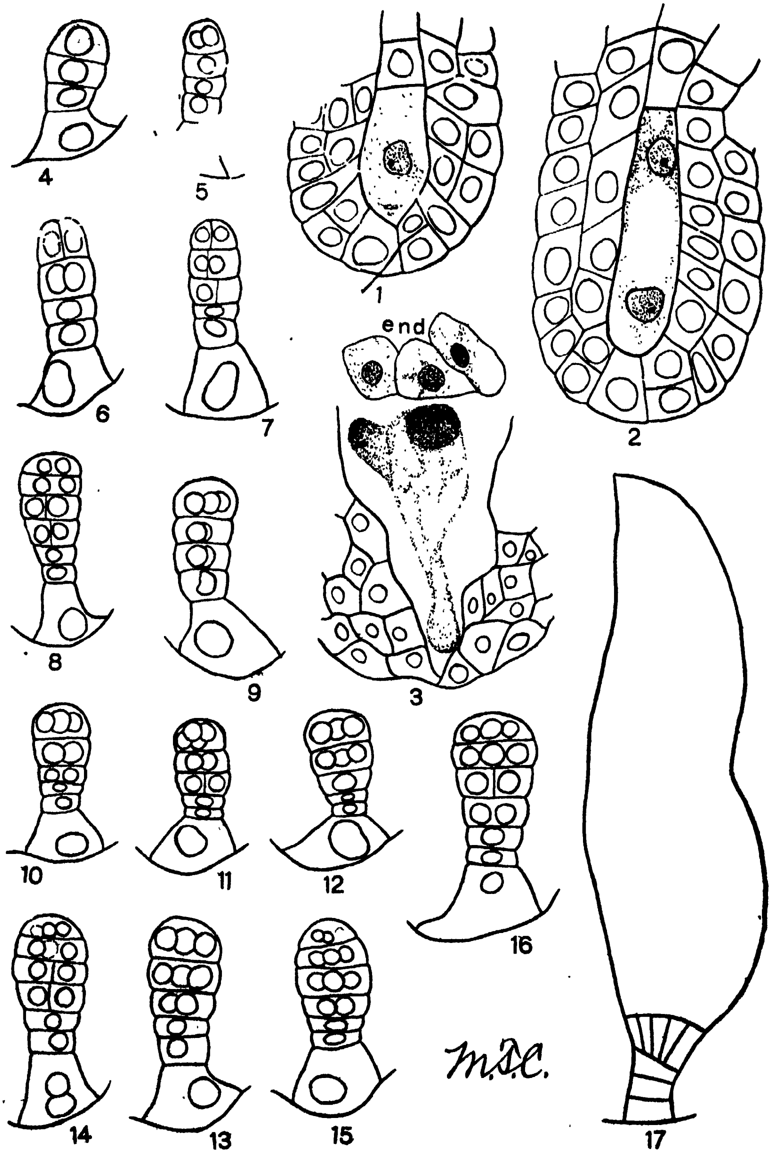
* The development of the Embryo-sacs and Embryos of Castalia odorata and Nymphæa advena. Bull. Torr. Bot. Club. 24: 211–220.

† Ikeda, T.—Studies in the Physiological Functions of the antipodals and Related Phenomena of Fertilization in Liliaceæ. I. Trycirtis hirta Bull. Coll. Agri. Tokyo Imp. University. 5: 41–72. 1902.

OHIO NATURALIST. *Plate VIII.*



COOK on "Embryology of Sagittaria."

The material for this paper was collected in a lagoon near San Antonio de los Banos, Havana Province, Cuba. Herbarium specimens have been deposited in the herbarium of the New York Botanical Garden.

ESTACION CENTRAL AGRONOMICA,
Santiago de las Vegas, Cuba.

EXPLANATION OF FIGURES OF PL. VIII.

Fig. 1. Functional megaspore.
Fig. 2. Two-nucleate embryo-sac.
Fig. 3 Antipodal end of sac in which the antipod disappeared, end —endosperm Same age as embryo in Fig 17
Figs. 4 to 16. Series of embryos.
Fig 17. Outline of embryo same age as Fig 3.

EXPERIMENTS TO TEST THE DIFFUSION OF HYDROCYANIC ACID GAS IN FUMIGATING HOUSES.*

A. F. BURGESS.

In February, 1906, a set of fumigation experiments was started to test the diffusion of hydro-cyanic gas in fumigating houses, with the object of determining the rapidity with which this gas diffuses, both in empty houses or boxes and also when they are filled with stock, as would be the case when they are in use. For this purpose permission was secured from the Agricultural Department of the Ohio State University to use a greenhouse in which soil experiments are conducted, and the fumigating box belonging to the Horticultural Department of the same institution was also furnished for the tests.

By placing the box on a truck which run on a track it could be pushed outside the greenhouse. In this way it was thoroughly aired without allowing the fumes to escape in the house and an opportunity was afforded to try several tests out of doors where the temperature was near the freezing point.

Description of Box: The box was lined with galvanized iron and was 4 ft. x 2½ ft. x 10 ft. inside measure, making a capacity of 100 cubic feet.

The cover was hinged at one end and was opened by using a rope and pulley at the other end. It shut on strips of felt, and, as the galvanized iron made the cover rather heavy, it would close very tightly without additional weights. Clamps were used. however, in order to make the box perfectly gas tight.

The generating jar was placed near the end at which the cover was raised, and, in order that no gas might escape while it was being closed, the cyanide was enclosed in tissue paper and dropped by a string through a small hole directly above the jar.

* Read before the meeting of the Ohio State Academy of Science.

As it was necessary to draw samples of air from different parts of the box at intervals during the tests, six holes were made, one at one end of the box, two on the side of the box near the top and bottom, and three in the end opposite the jar; the first near the middle and top of the box, the second half way from the top to the bottom of this end but at one side of the center, and the third near the lower corner. Sections of gas pipe about three inches long were threaded and screwed into the holes, so that about two inches extended outside the box.

The apparatus for drawing the samples to be tested was made by using sections of one-inch glass tubing eighteen inches long. To one end was attached a rubber tube, and a pinch cock was used as a cut off. Another rubber tube provided with a pinch cock was attached to the pipe. The glass tube was then filled with distilled water and attached to the rubber tube leading from the hole, and after opening the upper cock the water was gradually allowed to dribble from the lower rubber tube by partially releasing the other cock. After one foot of water had run from the glass tube, both valves were closed. By uncoupling the glass tube from the upper rubber tube and placing the thumb over the end, the gas caught was easily mixed with the water by shaking. The water solution was then placed in small bottles, which were tightly corked, and after a set of experiments was made samples were taken to the laboratory, placed in test tubes and treated with a solution of silver nitrate.

The presence of hydro-cyanic acid gas was indicated by a white precipitate. In case chlorides were present a similar preciptiate might be secured, hence the distilled water was repeatedly tested before using in order to assure accuracy of results.

No attempt at quantitative analysis was possible, in the limited time that could be devoted to the tests, but the precipitates secured were rated as "trace," "very slight," "slight," "good," "very good," and "heavy," in order to form a basis for determining results.

The writer is aware that the method followed can be improved and trusts that someone may have sufficient time to devote to this important work, in order to secure a more extended knowledge of the behavior of this gas in fumigating under various conditions.

By experiment it was found that the results secured by using a glass tube eighteen inches long were not reliable, as only a small amount of air from the box was obtained. Two tubes were then coupled together so that about two feet of water could be drawn out. This resulted in a fair sample being drawn for each test.

Hole	Test 1		Test 2		Test 3		Test 4		Test 5		Test 6		Test 7		
	Time	Ppt.	Time	Ppt.	Time	Ppt.	Time	Ppt.	Time	Ppt.	Time	Ppt.	Time	Ppt.	Ppt.
A.	5	G.	1	G	5	G.	5	H.	4	T.	4	H.	5	T.	T.
A.	25	H.	11	G.	25	H.	20	G.	26	G.	25	G.	24	G.	S.
B.	7	G.	2	T.	7	G.	6	G.	5	G.	6	S.	7	T.	0
B.	26	V. G.	12	G.	26	V. G.	21	G.	28	G.	26	G.	25	G.	S.
C.	15	G.	6	V. S.	15	G.	14	S.	12	G.	15	S.	15	T.	0
C.	36	V. G.	17	G.	36	V. G.	28	G.	35	S	35	G.	31	T.	0
D.	16	S.	3	G.	16	S.	8	G.	7	T.	9	0	9	S.	S.
D.	36	V. S.	13	S.	38	V. S.	23	G.	30	S.	28	S.	27	T.	0
E.	18	G.	7	G.	18	G.	15	G.	14	T.	22	T.	17	T.	0
E.	39	V. G.	19	G.	39	V G	30	G.	37	S.	37	G.	39	T.	0
F.	8	G.	8	G.	8	G.	16	G.	15	0	23	T.	18	T.	0
F.	28	V. G.	19	G.	28	V. G.	31	G.	39	S.	37	G.	39	T.	0
	P. M. Feb. 22		P. M. Feb. 22 Temp. 80°		P. M. Feb. 22, '06. Temp. 92° Floor of box wet.		Feb. 24 Temp. 80° Floor of box wet.		P. M. Feb. 26 Temp. 72° Box packed with stock. Solution tested after standing 23 hrs.		Feb. 28 Temp. 32° Box full of stock. Treated out of doors		P. M. Feb. 28 Temp. 70° Stock drenched with water. Results immediately after finishing Exp.		Results after precipitate stood 17 hours.

Chemicals used: In all tests the 1.1.3. formula was used: *i. e.*, 1 oz. potassium cyanide, 1 fluid oz. sulfuric acid, 3 fluid oz. of water. The cyanide was manufactured by Messrs. Merck & Company, of New York, and was 99% pure, and an excellent grade of commercial sulfuric acid was used.

The table gives the results obtained:

Experiments conducted by Prof. Wilmon Newell in Georgia (Bulletin No. 15, Georgia State Board of Entomology) showed that the violence of the reaction between the cyanide and diluted sulfuric acid subsided at the end of five minutes, and that no gas was evolved after ten minutes, if the cyanide was added so as to be well covered with the liquid.

From the data given in the table it appears that the gas first evolved is driven to the top of the box by the violence of the reaction, and that it passes in waves to the end farthest from the jar. It then seems to gradually permeate the lower parts of the box until thoroughly diffused, but the reactions are less marked in samples taken from the upper hole at the greatest distance from the jar after the box has been closed from thirty to forty minutes.

Results; Tests one and two which were made under normal conditions, the box being dry, showed that the gas was well diffused throughout the box at the end of forty minutes. The poorest results in both tests were shown at hole D at the end of the box opposite the jar. The sample taken three minutes after the charge was "fired" showed a good precipitate, and the amount of precipitate diminished as the time was lengthened. The test at hole E, which was at the same end of the box but several inches lower that hole D, gave an excellent precipitate.

In tests three and four, where the floor of the box was covered with water, practically the same results were secured, although in test four the sample taken at hole D gave a good precipitate.

In test five the box was packed with stock and the temperature was 72°. The results can hardly be considered conclusive, as the precipitate was allowed to stand in corked bottles for twenty-three hours before it was tested. In nearly every case, however, the samples showed a better precipitate the longer the time elapsed before the sample was taken.

Test six showed very similar results, although the box was placed out of doors where the thermometer stood 32°.

In test seven, where the stock was drenched with water, the results were much less satisfactory. A trace of gas was detected in each sample, and in a few slightly better results were noted. The precipitates secured in the test were allowed to stand seventeen hours and the condition is noted in the column adjoining test seven. It will be noted that enough of the precipitate

was redissolved to make the results unreliable; hence all notes should be made as soon as the tests are completed.

It is also possible to add an excess of silver nitrate, when testing the solution, and if this is done a slight precipitate may be redissolved and inaccurate results obtained.

SUMMARY OF RESULTS.

In drawing conclusions as to the rapidity with which the gas will diffuse to different parts of the fumigating box, it should be borne in mind that this will depend somewhat on the violence of the reaction, which will probably differ slightly in every test on account of differences in size in the lumps of cyanide used, the depth to which they are submerged, and the thickness of the paper which is used for wrapping.

In an empty box the gas diffused very rapidly, as is shown in tests one and two, every sample taken indicating its presence. Equally good results were secured when the floor of the empty box was drenched with water.

In the case of the box that was packed with stock it appeared that the diffusion was retarded, but reactions were secured, showing the presence of the gas in all the samples drawn in the longer periods. Very similar results were secured in both tests, and as far as the data in the experiment goes, no difference in result was noted, whether the temperature was normal (72°), or at the freezing point (32°).

From the results of test seven it appears that it is not desirable to fumigate stock that is drenched with water, although in this test a trace of the gas was found in each sample drawn.

Columbus, Ohio.

THE PUBLIC DRINKING CUP.*

Bacteriological Report.

EUGENE F. MCCAMPBELL.

It was suggested long ago that the public drinking fountain with its chained cups is decidedly unsanitary but few investigations are on record to prove this point scientifically. In the hope of adding something to the somewhat indefinite knowledge and to find out if possible exactly what objectionable species of bacteria were present, we made a series of ten bacteriological examinations of drinking cups from various fountains. In selecting cups for the examinations those which appeared to be decidedly unsanitary as well as those which appeared cleanly and connected with fountains which were used by the higher strata of society were selected.

* Read before the Ohio State Academy of Science, November, 1906, Columbus, Ohio.

The study of the bacteriology of the drinking cup is in a way closely connected with the study of the bacteriology of the mouth and the body surfaces surrounding the mouth. The bacteria which infest the mouth and proximate surfaces and orifices we would be quite liable to find on the cup which came in contact with that organ and with the surfaces of the body which are in immediate proximity. In comparing the species of bacteria found in our examinations with those reported as having been isolated from the mouth, we find our assumption verified in several cases.

The method of examination was as follows: A sterile cotton swab containing a little moisture was passed over the edge and interior of the drinking cup and this in turn drawn over the surface of sterile agar and Loefflers' blood serum contained in test tubes. The media was 1% acid to phenolphthalein. Cover glasses were also smeared and stained, after drying and fixing, with anilin gentian violet, Loefflers alkaline methylene blue, and by Grams' method. The cultures after being grown for 24 hours at 22° C. and 37° C. were diluted and plated in Petri dishes after which cultures were made according to the ordinary bacteriological technique. The bacteria were differentiated by means of Chester's "Manual of Determinative Bacteriology" and Matzuschita's "Bacteriologische Diagnostik." The pathogenic power of certain species of bacteria was tested on guinea pigs and rabbits. Frequently the cover glass preparations showed bacteria which we were unable to cultivate and consequently were unable to determine the species. Without doubt there were other bacteria present on the cups which were not revealed by cultivation or on cover glass preparation. No attempt was made to cultivate anærobic bacteria except in two cases.

Ex. No. 1. Swab was taken from a cup in connection with an ice tank in the hall of one of the state charity institutions. The cup was used in the main by visitors and employees. The cover glass preparation and cultural experiments showed the following bacteria to be present.

1. Micrococcus citreus* (Sternberg). Distributed in air normally.

2. Micrococcus pyogenes albus (Rosenbach). A pyogenic bacterium. Common. The pathogenesis of this particular organism was not great, guinea pigs dying only after 7 to 8 days. Widely distributed over the body surfaces.

3. Sarcina lutea (Flügge). Widely distributed in air and water.

4. Pseudomonas flourescens, var. liq. (Flügge). Widely distributed in air, etc.

Ex. No. 2. Swab taken from same cup as No. 1. A child (visitor at the hospital) had become sick and after vomiting was

given a drink from the cup. The swab was taken directly afterward. The cover glass preparation showed some bacteria which we were not able to cultivate. The following bacteria were shown to be present:

1. Sarcina lutea (Flügge). (See above).
2. Micrococcus liquifacians (v. Besser). First isolated from nasal mucous.
3. Micrococcus pyogenes aureus (Rosenbach) Pathogenic (pyogenic). Common.
4. Micrococcus pyogenes albus (Rosenbach). Pathogenic (pyogenic). Common.
5. Pseudomonas fluorescens var. liq. (Flügge). (See above.)
6. Bacillus vulgatus (Trevisan). Widely distributed.
7. Bacterium bucallis. Isolated first from healthy sputum.

Ex. No. 3. Swab was taken from a cup in connection with an improvised water tap and was used by several hundred workingmen. The cup remained in the dirt and mud underneath the tap the most of the time. The following bacteria were shown to be present.

1. Sarcina aurantica (Flügge). Widely distributed in air and water.
2. Micrococcus roseus (Bumm). Widely distributed in air.
3. Micrococcus pygoenes albus (Rosenbach). (See above.)
4. Streptococcus pyogenes aureus (Rosenbach) St. erysipelatis (Fehleisen). A virulent pyogenic bacterium which may cause a variety of disease conditions.
5. Pseudomonas janthina (Zopf). Distributed in water.
6. Spirillum rubrum (v. Esmarch). Distributed in water.

An effort was made to trace any cases of streptococcus infection which might have resulted from this cup but owing to the difficulty of getting at the workingmen this could not be done. It should be noted in this case that there are no soil bacteria present notwithstanding the fact that the cup was frequently contaminated. No anærobes could be demonstrated in this case.

Ex. No. 4. Swab was taken from a cup in connection with a public drinking fountain in Chicago. The following bacteria were shown to be present:

1. Sarcina lutea (Flügge). (See above.)
2. Sarcina aurantica (Flügge). (See above.)
3. Micrococcus pyogenes albus (Rosenbach). (See above.)
4. Bacillus formosus (Ravenel). Distributed in water.
5. Pseudomonas fluorescens, var. liq. (Flügge). (See above).
6. Bacterium mycoides (Flügge). Distributed in soil and water.

The primary cover glass preparation showed a leptothrix which could not be cultivated. This bacterium was in all probability Leptothrix bucallis maxima, (Miller).

Ex. No. 5. Swab was taken from a cup at a pump at a well on a country road along which there was a great amount of travel. The well was about 30 feet deep and covered with a board platform. The following bacteria were shown to be present:

1. Sarcina lutea (Flugge). (See above).
2. Sarcina aurantica (Flugge). (See above).
3. Sarcina tetragena (Koch). Slighty pathogenic and frequently associated with tubercular processes in the body.
4. Bacillus coli (Escherlch). The normal habitat is the intestinal tract of man and animals. It has been isolated from the mouths of healthy persons.
5. Bacillus subtilus (Ehrenberg). Widely distributed. Common "hay bacillus."

It was extremely dusty in the vicinity of this well. There was an outhouse about 30 feet from the well but on the side of the hill below. It does not seem probable that the well was infected from this source. No cases of typhoid fever or other disease were reported in the vicinity.

Ex. No. 6. Swab was taken from a cup in Chicago. The following bacteria were shown to be present:

1. Micrococcus aureus (Flugge). Distributed in air, etc.
2. Micrococcus pyogenes aureus (Rosenbach). (See above.)
3. Sarcina aurantica (Flugge). (See above.)
4. Sarcina lutea (Flugge). (See above).
5. Bacillus amylobacter (v. Tieghem). Widely distributed.
6. Bacillus coli (Escherich). (See above.)

The water coming to the fountain where this cup was found came from four miles out in Lake Michigan.

Ex. No. 7. Swab was taken from a cup in connection with a fountain in a city of 40,000 in Wisconsin. The following bacteria were shown to be present:

1. Spirillum rubrum (v. Esmarch). (See above.)
2. Sarcina lutea (Flügge). (See above.)
3. Micrococcus pyogenes aureus (Rosenbach). (See above).
4. Micrococcus radiatus (Flugge). Widely distributed.
5. Bacterium pneumoniæ (Zopf). (Penumococcus). Found frequently in normal mouths.
6. Bacillus prodigiosus (Ehrenberg). Widely distributed. ("Bloody bread bacillus.")

Ex. No. 8. Swab was taken from cup in a railway station in Chicago at six o'clock in the evening when the station was crowded with people returning from the city. The following bacteria were shown to be present:

1. Sarcina tetragena (Koch). (See above).
2. Sarcina aurantica (Flügge). (See above.)
3. Sarcina lutea (Flügge). (See above.)
4. Micrococcus roseus (Bumm). (See above.)

5. Micrococcus pyogenes albus (Rosenbach). (See above).
6. Micrococcus pyogenes aureus (Rosenbach). (See above.)
7. Bacillus prodigiosus (Ehrenberg). (See above.)
8. Bacillus amylobacter (v. Tieghem). (See above).
9. Saccharomyces cerevisiæ. (Yeast). Frequently found in the mouth.

Ex. No. 9. Swab was taken from a cup at a drinking fountain in a small town of 4,000. The water was running in a swift stream on the cups in the bowl beneath and consequently a great many bacteria were washed off. The following bacteria were shown to be present:

1. Spirillum rubrum (v. Esmarch). (See above).
2. Sarcina aurantica (Flügge). (See above.)
3. Bacillus sporogenes (Klein). A pathogenic bacterium which killed a guinea pig in 48 hours when inoculated subcutaneously. This species is very similar if not identical with Bacillus areogenes capsulatus (Welch). Anærobic.

Ex. No. 10. Swab was taken from a cup found in connection with a water tap at a large steel works. The cup was used by a large number of foreign workingmen. The following bacteria were shown to be present:

1. Micrococcus citreus (Sternberg). (See above.)
2. Micrococcus lutea (Cohn). Distributed in water and air.
3. Micrococcus pyogenes aureus (Rosenbach). (See above).
4. Sarcina aurantica (Flügge). (See above.)
5. Bacterium pneumoniæ (Zopf). (See above.)
6. Bacterium rugosum—An organism found normally in milk and cheese.

There were no bacilli demonstrated, *i. e.*, no motile forms.

SUMMARY.

The main facts to be noted as shown by these examinations are: (1) The comparatively few species of bacteria which are represented in the ten examinations; only 26 in all. (2) The presence in eight out of the ten examinations of the pyogenic or pus producing bacteria, viz.: M. pyogenes aureus and albus, etc. (3) The presence of the Steptococcus pyogenes aureus in one case and the Bacterium pneumoniæ in two cases. These bacteria have been repeatedly isolated from normal and diseased mouths and throats and according to some investigators are closely related if not the same organism. Reudiger* found the streptococcus in 30 out of 51 times in normal throats. (4) The absence of the mouth bacteria proper. Miller† describes 30 species of bacteria infesting the oral cavity. (5) The Colon bacilli reported may have been present in the water coming in contact with the

* Reudiger—Journal of American Medical Ass'n, Vol. 47. Oct. 13, '06
† Miller—Micro-organisms of the Human Mouth.

cup, it havi.,, b ... ted by sewage, or the bacteria might have come ... th ... of some person using the cup. In all ... came from sewage contamination of some ... interesting to note, however, that Bacillus coli has b... repeatedly to be present in the mouth of normal a... diseased individuals. (6) The presence of o... pat... bacteria, viz.: Sarcina tetragena and Bacillus ... nes, ... uld be noted. (7) The presence of certain water bacteria in nearly every case (sarcina, etc.) is undoubt... plained by their wide distribution. The lack of the ...aramyces groups (yeasts), with one exception, should be noted. These groups are almost always present in the mouth.

From these few examinations it is evident that the public drinking cup may serve as a carrier of infection, particularly pyogenic infections. There is no reason why other infections may not be carried in the same way. Cases have been reported where the Bacterium tuberculosis has been found in communion cups and cases are also on record where syphilis has been transmitted by contact with drinking cups. The general public is beginning to recognize the importance of the hygienic drinking fountains and fountains without cups from which the water flows in a slow stream which can easily be taken into the mouth without contamination, are beginning to be installed. In certain localities individual cups and paper drinking cups which can be used but once are quite popular. The sooner we recognize the importance of all these details in hygiene the sooner will we be able to control and prevent infectious diseases among us.

FOSSIL LAND AND FRESH-WATER MOLLUSCA COLLECTED IN DEFIANCE COUNTY, OHIO.

V. Sterki.

Four miles east of Defiance, Ohio, at the state dam, forming the north bank of the Maumee River, I found a deposit with fossil land and fresh-water mollusca. The material is fine sand, somewhat clayey, of light color, without any stones except in the top layer of about one foot, which is of different material, with broken stones (limestone), etc. Large trees are standing on it. So far as accessible, the bed is about eight to ten feet deep, and very rich in mollusca. What it is geologically, I do not know, but supposed it to be loess. In an hour and a half, I collected specimens of twenty-seven species, the large majority of them "land mollusca" and there is no doubt that many more will be found, and probably remains of other animals also.

At the same time, the recent m... vicinity should be collected carefully for compar... It ... be remembered, however, that most of the surface o... is now under conditions radically different from ... only fifty to seventy years ago. It is safe to sa... e are at present hardly more than five per cent of the ... living of what there were originally, that is, of individuals ... probably also, the number of species has considerably decr...

The following is a list of the mollusca found, with a few ... All of the species are now living in Ohio.

1. *Gastrodonta ligera*, Say, one specimen.
2. *Zonitoides arboreus* Say, one specimen.
3. *Hyalina radiatula* Alder, one specimen.
4. " *indentata* Say, one specimen.
5. " (or Zonitoides) *læviuscula* Sterki, a western species having the eastern limit of its recent distribution in Ohio, so far as known.
6. *Circinaria concava* Say, several specimens.
7. *Polygyra profunda* Say, several.
8. " *multilineata* Say, several.
9. " *albolabris* Say, one, large.
10. " *zaleta* Say (exoleta), a few.
11. " *clausa* Say, one fine specimen.
12. " *mitchelliana* Lea, one specimen.
13. " *thyroides* Say, a few.
14. " *elevata* Say, several, the commonest of all, except No. 25.
15. " *fraudulenta* Pilsbyr ("fallax Say" of authors), two.
16. " *inflecta* Say, two.
17. " *hirsuta* Say.
18. *Patula* (Pyramidula) *solitaria* Say, large, several.
19. " " *alternata* Say, a few.
20. " " *striatella* Anthony.
21. *Bifidaria contracta* Say, one. (*Pupa contracta* Say.)
22. *Succinea avara* Say, one, rather large.
23. " *retusa* Lea, one.
24. *Phyra* sp., one specimen, broken to fragments.
25. *Pomatiopsis lapidaria* Say, common.
26. *Pisidium compressum* Prime, two left valves.
27. " *fallax* Sterki, one valve.

Of *Unionidæ*, numerous fragments were found, but all too small to be identified; most of them were near the top layer. A large part of the shells were more or less damaged; few in perfect condition.

Fossil land and fresh water shells should be collected wherever found. But caution is necessary: they should not be cleaned more than required for identification, and under no condition should they be washed; water will damage them, especially will it loosen the outer layer of shell substance in the aperture, containing the characteristic parietal teeth of the Polygyræ etc.

New Philadelphia, Ohio.

Books Received.

"Boulder Reveries," by W. S. Blatchley, State Geologist of Indiana. A pleasing little volume bearing the title of "Boulder Reveries," is a late production of W. S. Blatchley, of Indianapolis. From the title one might be led to open the volume to read about boulders but the author makes it clear that living things have more attractions for him for on page 67 he writes: "I started alone this morn for my chosen rendezvous—the moss-covered boulder on the woodland slope. There I had an appointment with the squirrels, the marmots, the ants, the crows, the jays and all their kin. There I was to meet certain representatives which they were to send, and hold with them high communion on the peaceful Sabbath day. I started alone, and alone I wished to be, alone with my thoughts and the denizens of the woods."

"The little volume here offered was, with the exception of the last two articles, written in an old woods-pasture in Central-Western Indiana." It is an account of what the author saw of nature while strolling in the woods-pasture mentioned or while seated on one of the gray boulders which are reproduced from photographs for the book, and which Mr. Blatchley admires a great deal. Snakes, frogs, birds, insects and many other animals are mentioned and the brook, the trees and other plants come in for their share of attention now and then. The work is so written that the reader has no trouble in understanding the thoughts intended to be expressed and I am sure it will do much to stimulate the outdoor study of nature and interest in living things, no matter how lowly. One thought is put foremost, it seems to me, and that is, that all animals, even the snake, are much more interesting when alive, and when life is taken away there is nothing further in them to admire. The work is very commendable and should be read widely.

"Practical Zoology," by Professor Alvin Davidson, of Lafayette College. This book is sent out by the American Book Company as an elementary text-book treating of the structure, life history, and relation of animals. It is well illustrated and contains an abundance of facts taken largely from species that are of interest on account of economic habits. The idea is a good one for it seems that while a pupil is studying zoology it is well to use an economic species as a basis, and there is such a species of common occurrence to represent nearly every group of animals known. The book should have a wide usage in the place for which it is intended. —J. S. H.

KEY TO OHIO LOCUSTS IN WINTER CONDITION.

JULIO C. ORTEGA.

Robinia L. Trees or shrubs with alternate leaf-scars and usually with stipular spines; terminal buds absent; leaf-scars covering the small clustered or superposed axillary buds; the buds sunken and hardly projecting beyond the surface; pith cylindrical and of medium size.

1. Twigs glabrous; not glandular; a large slender tree with rough bark. *R. pseudacacia* L. Common Locust
1. Twigs very glandular or bristly. 2.
2. Twigs very bristly; with long glandular emergences; a much branching shrub. *R. hispida* L. Bristly Locust
2. Twigs very glandular, and with short gland-tipped emergences; a small tree with rough bark. *R. viscosa* L. Clammy Locust

A SPECIES OF HAWK NEW TO OHIO.—On Wednesday, February 6th, Professor W. C. Mills called my attention to a hawk which had been sent to him by M. Almer Hegler of Washington Court House, Ohio. The bird proves to be a specimen of the Gyrfalcon, Falco rusticolus gyrfalco, which has not been reported from the state before. Mr. Hegler writes as follows: "This hawk was caught in a steel trap while feeding upon a hen, but Mr. Carr who caught it is not sure that it killed the chicken itself, or whether some other hawk did the killing. It was caught two miles west of Washington Court House on Wednesday, January 30, 1907, on the farm of Jacob Carr."

The species is northern in its distribution and habitually wanders southward during winter weather, specimens being recorded for Kansas, Michigan and some of the New England States. The specimen was presented to the Zoological Museum, and is now being mounted so it may be kept in good condition as evidence of the first record of this fine species for Ohio.

JAMES S. HINE.

A BIRD NEW TO OHIO.—While comparing species of Ohio birds in my collection recently, with state records, I was surprised to discover that Leconte's sparrow, Ammordamus lecontei hitherto had not been recorded for the state. I have a specimen which I shot in a swampy meadow, near Cincinnati, Ohio, April 5th, 1880.

CHAS. DURY, Cincinnati.

MEETINGS OF THE BIOLOGICAL CLUB.

ORTON HALL, Jan. 7, 1907.

The club met in Orton Hall and was called to order by the president. After the minutes were read Prof. Osborn gave a report on "The Cicadadæ;" he discussed the distribution of the family and mentioned some of the factors which influence this distribution.

Prof. Landacre gave a review of the Zoological and Botanical papers read at the American Association for the Advancement of Science. Prof. Ball did the same for the papers on Economic Entomology.

Prof. Osborn spoke of some of the things taken up by the council at that meeting.

A. J. DeFosset and E. V. Jotter were elected to membership.

J. N. FRANK, *Secretary.*

The February meeting of the Club was held in Orton Hall, Monday evening, February 4, 1907, Mr. Hambleton presiding.

The minutes of the previous meeting were read and approved. The paper of the evening was read by Prof. Stauffer, "On the Occurrence of the Hamilton in Ohio." A discussion on the habits of birds followed, in which Mr. Metcalf, Prof. Hine and Schaffner took part. Prof. Schaffner reported some of the botanical papers read at the A. A. A. S. The Club then adjourned.

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ROBBER FLIES OF THE GENUS PHILONICUS.

JAMES S. HINE

Philonicus was proposed by Loew in Linnaea Entomologica, Volume IV, page 144, to receive a single European species which had been known under the name of Asilus albiceps. After studying the last named European species carefully, I find that we have at least four distinct North American species which are congeneric with it. Bellardi referred two Mexican species to the genus, but Williston concludes that one of these belongs to Heligmoneura and has published the synonymy in Biologia Centrali Americana. So the four species are made up of three from the United States and one from Mexico.

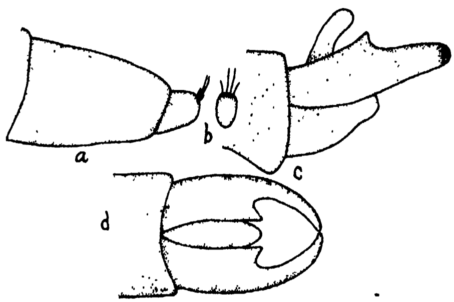
It appears that American authors have been misled by the fact that Loew proposed Philodicus as a generic name in another section of the same subfamily, thus giving two names so near alike as to be easily confused. His description of the latter genus is published in Linnaea Entomologica, Volume III, page 391. The singular thing about the matter is, that Loew himself in Dipteren Fauna Sudafrika's, page 144, uses Philodicus where he intended Philonicus, and I suspect this fact also has proven a stumbling block to some students.

So far as known at present there are no species of Philodicus in North America, so the name is most likely misplaced when used in reference to Nearctic Diptera.

In his studies of European Asilinae Loew used many characters taken from the oviduct; thus he separated the females into two groups, one in which the oviduct is conical and one in which the oviduct is compressed. European species appear to be separated readily by this character, but in our species, especially after they are dry, some difficulties are encountered,

for often it is impossible to say whether the oviduct is conical or flattened.

The species of Philonicus, so far as known, are all medium sized species; the facial gibbosity is small with comparatively few bristles; oviduct conical, end lamella with four apical bristles on the upper side. Male genitalia, as seen from the side, of ordinary size, the side pieces each have a distinct prominence at the middle above, then they are narrowed and curve inward until they almost touch at the tips. From above these same pieces are wide for slightly more than half their length, then distinctly cut out to apex with a distinct open space between them.



Philonicus albiceps Meig. *a*, tip of female abdomen to show its form and the apical spines; *b*, view of last segment from the end; *c*, tip of male abdomen as seen from the side; *d*, same from dorsal view.

It appears that what Dr. Williston has called Stenoprosopis arizonensis should be included in this genus; at least specimens that agree in detail with his description are at hand and the characters of Philonicus are very plain in both sexes, but it is a question whether the oviduct is conical in the females.

The following key may be used as an aid in separating the known Nearctic species:

1.	Legs in most part yellowish. 2.	
	At least the femora of all the legs black. 3.	
2.	Wings distinctly reddish.	*rufipennis.*
	Wings hyaline.	*arizonensis.*
3.	Legs black except the extreme bases of the tibiæ.	*tuxpanganus.*
	Legs with the tibiæ and tarsi largely reddish.	*obscurus.*

Philonicus arizonensis Williston. Gibbosity of the face very small, with a few white bristles; front and face white; bristles and hairs of the head all white; first segment of the antenna black, second more or less yellowish and shorter than the first, third black, exclusive of the arista about as long as the other two together, arista slender and slightly shorter than the third segment. Thorax gray pollinose with a middorsal gray stripe, narrowly divided before, and two spots on each side, one before and the other behind the transverse suture. These brown markings

are not so prominent as in some of the other species of the genus. Wings hyaline; legs largely reddish, coxae colored like the thorax, femora with more or less black on the outer side, especially on apical half; tibiae and metatarsi black at apex, other tarsal segments mostly black. Abdomen dull black, before the incisures with narrow white bands, in the front margin of which there are on either side in each two or more bristles.

Length, 17 millimeters. Male and female taken in southwestern Colorado, July 14th, 1899, by E. J. Oslar.

Philonicus obscurus n. sp. General color dark with the wings pale fumose all over. The abdomen has different shades according to the view taken. Gibbosity of the face small with a few bristles, part of which are black and the others white; face with gray pollen, front with some small black bristles and occiput above with a row of black bristles; antenna black, first segment longer than the second, third, exclusive of the arista, about as long as the other two; arista a little shorter than the third segment. Thorax brownish gray pollinose, with a middorsal dark brown stripe narrowly divided before, and on either side two spots of the same color, one before the transverse suture and the other behind it. Wings uniformly darkened all over, but it would not be far wrong to say they are hyaline. Legs black and reddish; coxae colored like the sides of the thorax, femora entirely black except that the posterior ones are often narrowly yellowish at the extreme base; tibiae reddish at the base and black at the apex; the extent of these two colors on the tibiae is somewhat variable, the tendency being for the black to be most extensive on the outside and the reddish on the inside; feet with the first two segments reddish on basal part, other segments usually entirely black. Abdomen opaque black, before the incisures with gray bands, in the front margin of each of which on either side are two or more distinct bristles.

Length, 13–16 millimeters. A male from Kentucky, across the river from Cincinnati, collected by Chas. Dury, two females from Washington, D. C., and males and females from Riverton, N. J. and Pendleton, N. C. procured from Prof. Chas. W. Johnson.

Philonicus rufipennis n. sp. Gibbosity of the face small, furnished with a few bristles which usually are all white, but in one or two of the specimens studied there is now and then a black bristle intermixed; face and front with silvery pollen; a row of black bristles on the occiput above; first segment of the antenna black, second largely yellowish and shorter than the first, third black, not quite as long as the first two together, arista slender, about the length of the third segment; beard entirely white. Thorax gray pollinose, with a middorsal brown stripe narrowly divided before, and two spots of the same color on either side, one before and the other behind the transverse suture; coxae

gray, usually an elongate blackish spot on the front side of each femur and extreme apexes of all the tibiae and tarsal segments blackish; otherwise legs red. Wings uniformly reddish yellow all over, halteres pale yellow. Abdomen opaque black with a narrow gray band in front of each incisure and in the front margin of each of these bands there is on either side two or more bristles. The reddish wings and legs taken together are characteristic of the species.

Length, 15 millimeters. Specimens from Douglas County, Kansas, taken in May and June by E. S. Tucker.

Philonicus tuxpanganus Bellardi. Gibbosity of the face small with few bristles which are black above and white below; face rather narrow and clothed with white pollen; antenna black, first two segments with black hair, second segment shorter than the first, third segment slightly shorter than the other two together. Arista much slenderer than the third segment and a little shorter, palpi and proboscis black, beard white, Thorax everywhere clothed with silvery pollen, above with two black stripes near the middle of the dorsum and two spots of the same color on either side, one before and the other behind the suture; wings with a slight smoky tinge but this is so faint that they well may be called hyaline and there is no apparent darkening at the apex as in many species of the subfamily. Coxae silvery, extreme bases of all the tibiae reddish, otherwise legs black with black bristles; halteres pale throughout. Abdomen shining black above with narrow white bands in front of the incisures; in the front border of each white band there is on each side two or more medium sized bristles, more prominent in the male than the female; venter of the abdomen silvery and with a few white hairs.

Length, 12–15 millimeters. Taken at Gualan, Guatemala, January 13, and at Mazatenango, Guatemala, February 3, 1905.

WINTER KEY TO OHIO CHESTNUTS.

S. B. Stowe.

Castanea Adans. Trees or shrubs with furrowed bark and terete branches; twigs with rather prominent lenticels, not zigzag; leaf scars alternate; bundle scars several, scattered; stipular scars present; terminal bud present or wanting; axillary buds sessile, single, with several exposed scales; pith small, solid, more or less five-angled.

1. Large trees; twigs glabrous and shining; outer bud scales glabrous. *C. dentata* (Marsh.) Borkh. Chestnut.

1. Shrubs or small trees; twigs pubescent or puberulent, dull; outer bud scales pubescent. *C. pumila* (L.) Mill. Chinquapin.

NOTES AND METHODS ON COLLECTING AND PRESERVING THYSANURA.

ALMA DRAYER JACKSON.

In studying the Thysanura during the past two years many difficulties were encountered in regard to collecting and preserving specimens which could be used with any satisfaction a few months after they were mounted. A great deal of time and many specimens were lost before anything like satisfactory results were obtained. The Collembola are especially difficult to handle since their chitinous body walls are almost impervious to ordinary fixing agents. If dried they shrink beyond recognition and the same difficulty is met with in using numerous reagents. It is hoped that these methods and reagents which have been found satisfactory in studying the Thysanura may prove helpful in working with other insects whose bodies are of like texture, and whose habits are similar.

In order to facilitate the study of these insects two methods of field collecting are employed; the specimens are either collected and brought to the laboratory alive, or are collected in some reagent which will keep them in as perfect and natural a state as possible. The latter method is very difficult, since reagents that will keep other insects, or even some species of the Collembola in perfect condition will shrink or distort other species to such an extent that they are useless.

For most purposes it is more desirable to collect these small insects alive and bring them into the laboratory for fixing.

COLLECTING IN CAPSULES.—One of the most successful methods for collecting alive I have found to be by the use of large size capsules. A small piece of lense paper was placed in each capsule to absorb moisture from the insect and give them something to crawl over. By being careful the larger end of the capsule may be placed over the insect, and if it does not choose to go into its new quarters immediately may be gently urged on by means of a small brush pushed under the edge of the capsule. It is best not to place more than two or three insects in one capsule as they require careful handling to keep them alive for any length of time. Air may be admitted to the capsule by puncturing one end by a fine pin point. It is important that the insects be kept alive since the antennae and body begin to shrink almost immediately after death.

COLLECTING IN LARGE MOUTHED BOTTLES.—For this method of collecting one should be provided with several large mouthed bottles and a good sized funnel. The funnel is placed in the neck of the bottle and pieces of decaying wood, bark, etc., on which the insects are hiding are gently tapped or pounded

together over the funnel. The insects falling on the smooth surface tumble down into the bottle. Damp wood, leaves, etc., should be placed in the bottle for the insects to crawl over.

COLLECTING IN FIXATIVES.—For fixing the insects in the field the collector should be provided with a large number of small round bottomed vials filled with the fixative. Two or three fine camel's hair brushes, a large square of white oil cloth and a chizel or pick for dislodging bark or decaying wood.

Pieces of bark, wood, etc., may be pounded together over the cloth on which the insects will fall. The tip of the brush is then moistened with the fixative and quickly placed over the insect. They should be held under the brush until stupified and then placed in the fixing agent; the latter process being easily accomplished if the brush is sufficiently moistened. The matter of proper fixation is very important. Almost all Thysanura are impervious to water. Smynthuridae will float about for days or even weeks on 75% alcohol, and the addition of a little glycerine to 85% alcohol will prevent them from sinking. While 75% alcohol will kill the specimens it fails to fix the tissues and they soon shrivel and become useless. In working with the Thysanura I have found the following reagents to be the most useful both for form and general appearance, as well as internal anatomy.

GLACIAL ACETIC ALCOHOL:

Glacial Acetic Acid.........................1 part
Absolute Alcohol ....1 part
Corossive Sublimate Saturation.

For field collecting this is one of the best formulas I have used. Specimens are fixed within a few seconds, but may be left in the reagent for several hours without detriment. They may be preserved indefinitely in 85% alcohol, or gradually transferred to pure gylcerine as follows: Place the specimens in a stentor dish, and add glycerine from one side. After a considerable amount of glycerine has been diffused through the reagent the cover should be removed from the dish and the glacial acetic and the alcohol allowed to evaporate.

ACETIC-GLYCERINE FIXING AGENT:

Glacial Acetic Acid........................10 parts
Glycerine ....1 to 4 parts
Corrosive Sublimate Saturation.

Possibly better results may be obtained, especially as to preserving the color by the use of this reagent. Specimens will be properly fixed in a few minutes, but may be left in the solution for some time. On exposure to the air evaporation of the glacial acetic takes place leaving only the glycerine. After this has

proceeded for some time the glycerine should be changed frequently in order to dispense with as much corossive sublimate as possible.

Boiling Absolute Alcohol.—This is another method which is particularly applicable for laboratory use. Place the specimens in a straight necked vial and pour over them boiling absolute alcohol. Leave for from five to fifteen minutes and transfer to 95% alcohol, and preserve permanently in 85%. The specimens when properly fixed may be left in this grade indefinitely without shrinking. The changes should be made between the different grades of alcohol about every ten or fifteen minutes. If it is desired to mount the specimens in balsam, xylol may be added gradually to the absolute alcohol. Or on the other hand glycerine may be added and the alcohol allowed to evaporate. The alcohol may be used cold in the same manner as described above; however, there is less liability of shrinking the specimens if the temperature is raised to the boiling point. No more time should be occupied in transferring the specimens from alcohol to balsam than is ablsoutely necessary however, if the transfer is made too rapidly the specimens will cloud. Cedar or clove oil may be used in place of xylol with less liability of shrinkage. While balsam mounts are almost always shrunken they are almost indispensable for the detailed study of the claws, spring, and hairs of the insect.

Sugar Jelly Mounting Media.—One of the best methods for examining the Thysanura is as follows: Specimens that have been in pure glycerine for a few hours are placed in a thick syrup consisting of apple jelly and glycerine. After staying in this syrup for an hour or so they are mounted in pure apple jelly in which a very small amount of carbolic acid or corossive sublimate has been added. The clearest jelly possible should be selected, melted, and a few drops of carbolic acid or corossive sublimate stirred in and then filtered through two or three folded filters. The cover glass should be rung with some good cement, Bell's having proved most satisfactory, and afterwards finished with black enamel. This is a method that has been tried and found successful for mounting Papirius, and is the only means by which I have been able to preserve both their form and color. However, the utmost care must be observed throughout, giving the fixing agents plenty of time or the specimens will shrink destroying their correct form and color.

Specimens may also be examined in pure cedar or clove oil which has been boiled down to a thick syrup. The only way such slides can be finished is by ringing them with Bell's cement. This method is excellent for showing some of the finer details.

Live boxes for these minute insects are very easily and simply constructed, when one wishes to study their habits in the lab-

oratory. A piece of damp, decayed wood should be selected with a few crevices in it under which the insects may secrete themselves. Put the insects in a good sized straight necked bottle with a few bits of decayed leaves and dirt in the bottom. The wood should be wedged in tight enough so that it will not roll around and crush the insects. By keeping the wood a little moist all of the time, and in a dark place most Thysanura will thrive apparently quite as well as in their natural surroundings.

THE DEVELOPMENT OF THE SPORANGIUM OF EQUISETUM HYEMALE.*

Lon A Hawkins.

The sporangium of Equisetum has been the subject of considerable study. The first work of importance was by Hofmeister who seems to refer the whole of the sporangium to a single cell. Later Russow while verifying many of Hofmeister's statements did not agree to this, but considered it to be of the eusporangiate type, the sporogenous tissue as arising from the division of a single cell but part of the walls and tapetum coming from the surrounding tissue. This is now the generally accepted view.

Goebel (1) gives an account of the development of the sporangium of *E. palustre* or *E. limosum* which he illustrates with two figures. According to this description it seems that the first division of the sporangial initial is periclinal and separates the primary sporogenous cell from the primary wall cell. In subsequent development the primary sporogenous cell divides much more rapidly than the other and we have a large mass of sporogenous tissue formed while a segment of the rather thin wall of the sporangium is all that comes from the primary wall cell.

This is one of the points where Bower (2) disagrees with Goebel. In his study of *E. arevense* and *E. limosum* he came to the conclusion that Equisetum is eusporangiate; that the contents of the sporangium are ultimately referable to a single initial; that the first division is periclinal, the inner cell and part of the outer going to form spores; and that the sporogenous tissue cannot be referred to a single cell as Goebel holds.

Campbell (3) does not seem to agree with Bower either as to the location of the superficial initial or as to its subsequent development. His account agrees more closely with that of Goebel. There appears no statement of the species he studied but it was probably *E. telmateia*.

* Contributions from the Botanical Laboratory of Ohio State University XXX.

This is apparently all that has been published on the *sporangia* of the group up to the present time and it seemed that some of the other members should be studied in order to compare them with *E. limosum* and *E. arvense* as interpreted by Bower. *E. hyemale* L. was selected for examination and the sporangium studied, special attention being given to the younger stages.

The writer's thanks are due to Dr. R. B. Wylie, under whose direction this work was begun, and to Professor John H. Schaffner who supervised its completion, for their many helpful suggestions and valued assistance.

INVESTIGATION.

The material was gathered May, 1905 and 1906, near Sioux City, Iowa, along the north bank of a ravine in rather exposed places and on the north slope of a railroad grade. The killing solution used was a modification of Fleming's formula and was prepared as follows:

Chromic acid	.15 grams.
Acetic acid	.35 cubic centimeters
Water ....99.	cubic centimeters

The siliceous protective leaves were removed before the young strobili were killed, they were run up through the alcohols in the usual manner and imbedded in paraffin with a melting point of 60 degrees C. The strobili were sectioned longitudinally, sections being cut seven mic. thick. The younger stages were stained in Delafield's haemotoxylin, the older in sanfranin gentian violet orange G. combination.

The young strobilus grows by means of an apical cell, cutting off alternate segments and these dividing both periclinally and anticlinally rather rapidly. No definite epidermal layer is differentiated. About the time the apical cell has advanced twelve or fourteen segments beyond a certain point and the outer cells have didvied once or twice periclinally the papilla which is the young sporangiophore is noticeable. The first stages of this process are brought about by divisions in the hypodermal tissue and the outer layer does not seem to divide until there is a distinct protuberance. About this stage there is noticeable near the base of this papilla a cell (Fig. 10) with a large vesicular nucleus. It is somewhat larger than its fellows and its cytoplasm gives a peculiar reaction to the stain. It seems to agree rather closely with the initial figured by Bower for *E. arvense* and was thought to be homologous with it. It divides by a periclinal division forming an upper and a lower cell but in subsequent development only the upper cell functions in the formation of sporogenous tissue the lower one being sterile. In this paper therefore the upper and outer cell resulting from

this periclinal division is taken as the first cell of the sporangium, and its development will be traced as closely as possible.

The division of this first cell is anticlinal and may occur either radially to the sporangiophore (Fig. 3) or in a plane perpendicular to the radius (Fig. 2). But no case was found where it occurred periclinally. The second division takes place either periclinally or anticlinally and in either case the divisions in the two daughter cells are the same so that we have two plates of two cells each side by side. Further development of the sporangium takes place in various ways.

In general, however, the sporangia may be divided into two types which are correlated with the direction of this second division. It was noticed that when the wall was periclinal after a radial anticlinal division of the first cell, the sporangium formed was broad and rounded (Figs. 5, 14–18), while if the wall was anticlinal the sporangium was long and slender (Figs. 2–4, 6–13, 19).

The next division of the broad rounded type of sporangium, where the second wall is periclinal, is in the outer of the two pairs of cells which divide anticlinally (Fig. 5). These daughter cells may then divide either periclinally or anticlinally, the usual method, however, is for two or three walls to be formed anticlinally after which these cells divide (Figs. 14–16). The development of the inner cell is retarded (Figs. 15, 16) until about the time the tapetum is differentiated when it becomes active (Figs. 17, 18). The progeny of the outer cell does not divide as rapidly from now on as that of the inner cell. About this stage there is a differentiation of wall and tapetum and a little later the cells between the wall and tapetum become flattened along with the tapetum as the sporogenous tissue develops. The sporogenous tissue seems to come from both the inner and outer cells (Fig. 18).

The long slender type of sporangium, in which the second division is anticlinal, shows striking differences in development. The third division is periclinal and seems usually to be in the upper of the two pairs of cells (Fig. 6) both pairs, however, divide rather rapidly (Figs. 6–13) until in radial section there are two long rows of cells very separate and distinct from each other. When the number of cells in longitudinal section of the sporangium is about twelve or fourteen (Fig. 13) the tapetum begins to form and soon after, the cells of the sporogenous tissue begin to divide in the other direction also and a sporangium develops which compared with the other kind is rather long and slender (Fig. 19). This method of forming the sporangium does not seem to have been recorded by any who have worked on Equisetum though Bower mentioned that in *E. limosum* the development was somewhat irregular. . . . .

Later stages of the sporangium are similar to what Bower found for *E. limosum* and *E. arevense.* A large number of sporocytes are developed, about forty in radial section, many of which become disintegrated during the formation of tetrads.

The most striking difference is in the first stage of the sporangium. The large cell (Fig. 1) which cuts off the first cell of the sporangium is very sharply differentiated from its fellows by the size and structure of its nucleus and by the way its cytoplasm stains. The lower cell and its descendants are distinctly differentiated from the rest of the tissue through several stages of the sporangium. The outer half of the large cell, the first cell of the sporangium, always divides anticlinally which is contrary to the usual method of division of the sporangial initial in the Equisetales. Taking these facts into consideration together with the position of this large cell, the conclusion is reached that it is homologous with the sporangial initial figured by Bower for *E. arevense* and that in *E. hyemale* the sporogenous tissue comes entirely from the primary wall cell while the inner cell is sterile.

SUMMARY AND CONCLUSION.

1. Equisetum hyemale is the of eusporangiate type.
2. The sporogenous tissue comes from a single cell.
3. The first wall is periclinal the inner cell being sterile, while the sporogenous tissue comes entirely from the outer cell.
4. The tapetum comes from the cells surrounding the sporogenous mass.
5. There are two types of sporangia differing in development and governed by the direction of the second division.
6. Many of the sporocytes are disintegrated during the formation of tetrads.

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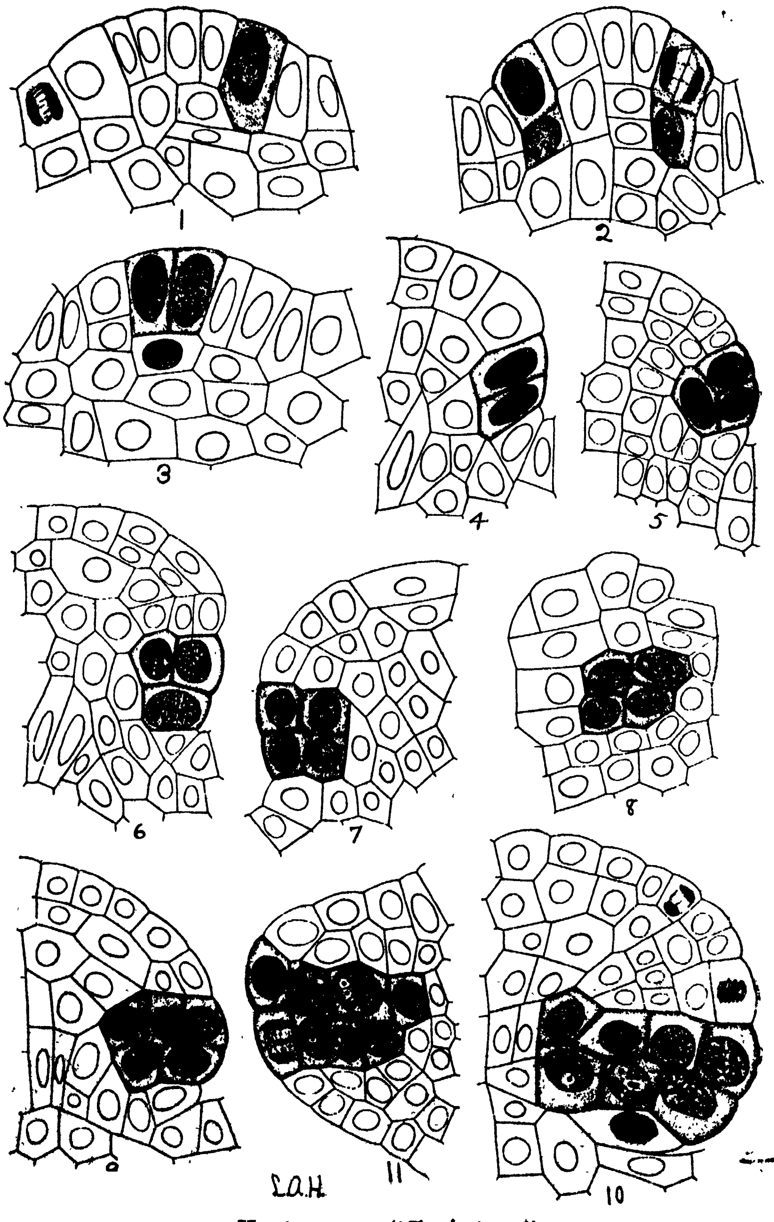
3. CAMPBELL, D. H. "Structure and Development of Mosses and Ferns," page 475.

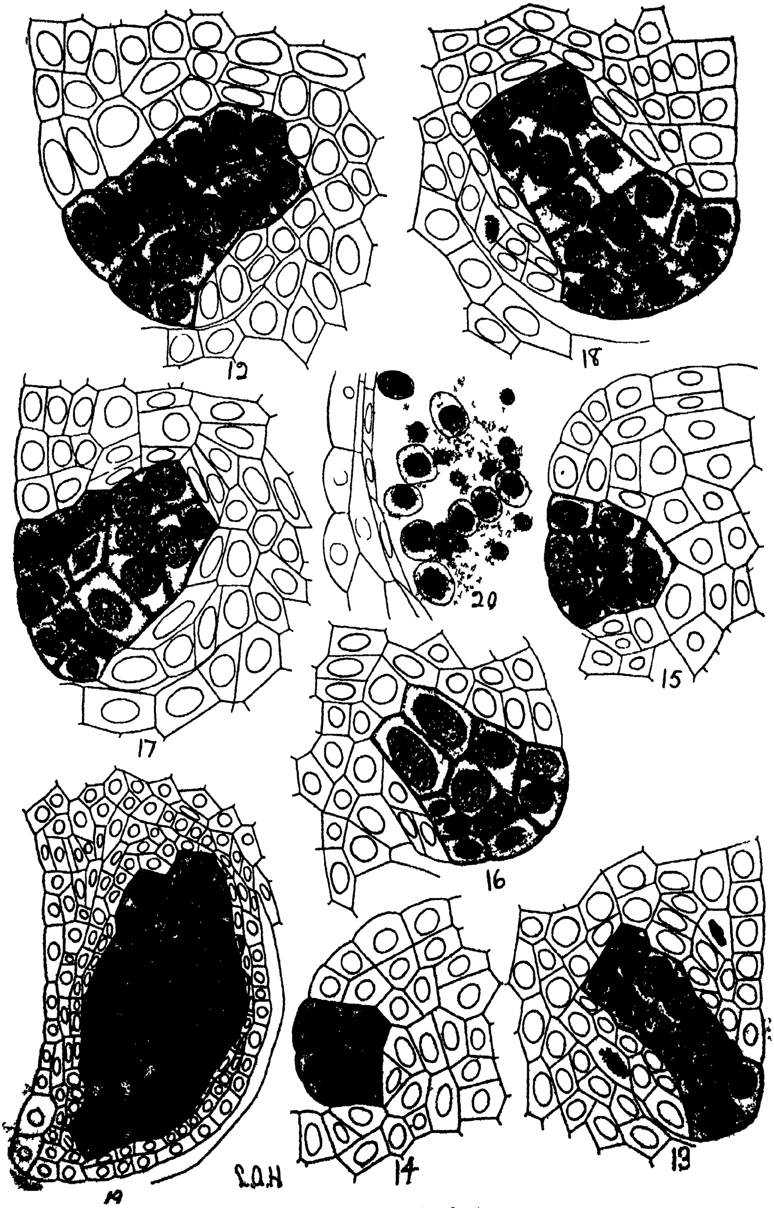
EXPLANATION OF PLATES.

All figures were made with a Bausch and Lomb camera lucida and a Bausch and Lomb 1-12 oil immersion 1.32 N. a. objective with Leitz No. 4 ocular was used for all but Fig. 19 where a Leitz 1-7 objective with a No. 2 ocular was substituted. The original magnification was approximately 1500 diameters for all but Fig. 19 which was about 670 diameters. Drawings were reduced to one-fourth diameter of original magnification.

OHIO NATURALIST. *Plate IX.*



HAWKINS ON "Equisetum."



Hawkins on "Equisetum."

Fig. 1. Incipient sporangiophore showing cell which will cut off the first cell of the sporangium.

Fig. 2. Young sporangiophore showing periclinal division and first anticlinal division perpendicular to a radius of the sporangiophore.

Fig. 3. Tangential view of a young sporangiophore in which the division of the first cell is radial.

Fig. 4. Radial view of four-celled stage of young sporanigum, all divisions having been anticlinal.

Fig. 5. Radial view of six-celled stage of broad, rounded sporangium second division periclinal.

Figs. 6, 7. Radial views of six- and eight-celled stages of long, slender sporangia.

Fig. 8. Cross section of sporangium the same stage as Fig. 7 from an adjoining sporangiophore.

Figs. 9, 10. Radial sections of long, slender sporangia showing five and seven cells respectively.

Fig. 11. Longitudinal section of sporangium of the same type as Fig. 10 and from an adjacent sporangiophore, cut tangential to the strobilus.

Fig. 12. Later stage in the development of a long, slender sporangium; tapetum not yet differentiated.

Fig. 13. Section of long, slender sporangium, showing formation of tapetal layer; five outer cells slightly differentiated from the sporogenous tissue will form wall.

Fig. 14. Early stage in development of broad, rounded sporangium; the second division was probably periclinal.

Figs. 15, 16. Later stages in development of broad, rounded sporangia; the heavy lines indicate the position of the first periclinal division.

Fig. 17. Broad rounded sporangium, the tapetum beginning to form; the heavy line indicates the position of the first periclinal wall.

Fig. 18. Later stage in development of broad, rounded sporangium, the tapetum and wall differentiated and position of first periclinal division indicated by heavy line.

Fig. 19. Sporocyte stage of long, slender sporangium; the heavy line shows position of early anticlinal division.

Fig. 20. Section of older sporangium showing disintegrating sporocytes.

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A COLLECTING TRIP NORTH OF SAULT STE. MARIE, ONTARIO.

E. B. WILLIAMSON.

This little trip of two weeks' duration was made especially in search of dragonflies along the line of the Algoma Central Railroad north of Sault Ste. Marie, Ontario. Every effort was made to collect the greatest possible number of specmiens and species in this group, and the other records of animals and of plants which follow are based upon the most desultory collecting. Those who have studied these miscellaneous collections have furnished me with notes which are published in this paper over the authors' names.

The Algoma Central Railroad is one of the Clurg enterprises. Aimed across a wilderness at the distant Hudson Bay, it was to be the highway over which the golden fleece should be brought to the Soo. The power of the rapids of the St. Marys River, the mines and forests of the Algoma District, a railroad route to Hudson Bay, homes for settlers, these were the things which the creative imagination of a man saw as material for the building of a great and flourishing empire from which he and his associates should receive wealth hitherto undreamed of. But the workmen came down from the mountains for their long due pay and troops protected the officers of the several companies. The Algoma Central has been built for only 70 miles. These 70 miles are, however, well constructed and a trestle at Bellevue is said to be the highest and longest wooden structure of this kind in the world.

At once after leaving the Soo the road passes into mountains which are uninterrupted from that point to the inland terminus. Cuts through solid rock reveal beautiful folds of the pink and dark green layers of gneiss or the more uniform black, gray or

pink of a granitic mass. Near the track one may see a precipitous cliff, bold, rough, scarred and menacing, or some rounded and smooth knob with the steep sides bared of vegetaiton by forest fires. Great beds of stratified gravel and sand are exposed by railroad cuts and by the action of the streams. At several places a very tough, light blue, laminated clay was seen. In some cases streams flowed over this clay; in other cases it was in banks above the stream bed. This clay is very resistant to the action of water and is extremely slippery where water is flowing over it. Where broken down in large masses by stream undermining and subsequently subjected to erosion at varying angles from time to time, the exposed laminations often form beautiful patterns.

The railroad after a short distance north of the Soo to a point north of Heyden is in the drainage area of the Root River, a tributary of the St. Marys River below the Soo. Before reaching Searchmont, 30 miles north of the Soo, the road crosses tributaries of the Goulais River, and from here to its northern terminus it is in Lake Superior drainage.

The vegetation which clothes these granite masses is "hardwood brush." The view from the railroad of the Goulais valley, bounded by its great vari-green mountains is most beautiful. On a following page are lists of the arboreal species and of the plants which I collected.

The short summer of this region results in a condensation of seasonal range of the species of any group which depend on abundant light and heat for their activity. For example, on July 30th, I saw Iris, a "spring flower," and Solidago, an "autumn flower," in bloom literally side by side. Of dragonflies I took Chromagrion conditum and Aeshna Z. (see list of dragonflies following) about the same lake on the same day. On that day at latitude 42 degrees north in Indiana Chromagrion had probably entirely disappeared for the season and Aeshna if it had yet appeared at all, would certainly be found in very limited numbers. This condensation is greatly to the advantage of the collector, at least in certain groups. Possibly for a short trip no better season than the first half of August could be chosen for collecting in this region. About the first of August the black flies have nearly disappeared, and I was but little bothered by these pests or by mosquitoes or sand flies. It is probable I failed to get certain Cordulines and Gomphines which may be on the wing in this region earlier in the season, but on the whole I believe I took a fair representation of the species. At my home at Bluffton, Indiana, no two weeks of the season (April 1st to Nov. 21st) could be selected which would yield so nearly all the species of that locality.

Collections were made at the following points along the Algoma Central. On July 29th and 30th, a little collecting was done about the Soo, and on July 30th I arrived at Heyden, about thirteen miles from the Soo. While at Heyden I lived with Mr. William Marshall who is operating a shingle mill there. The afternoon of July 30th was spent along Mud Lake, near the shore of which Heyden is situated ,along a similar lake just above Mud Lake, and along the small marshy stream connecting the two lakes. July 31st a wagon trail west of Heyden was followed for about two miles to a beaver dam on a small stream; this stream was followed to its mouth in Root River, and Root River was followed down stream to where it is crossed by the railroad. August 2d was spent along Root River below the point where the railroad crosses it and at the stony ripple just above this point On August 3d and 4th Stony Lake was visited. This is a beautiful body of water lying in the hills high above and to the east of Mud Lake, into which it discharges its overflow. I was told at Heyden that the name was local as the lake does not appear on any maps of the district The precipitous shores of this appropriately named lake made exploration difficult and almost fruitless or dragonflyless The greater portion of the two days was spent about the lower, pond-like, end of the lake, where a dam, constructed by Perry for getting out pine, still holds the lake above its natural level. About this portion of the lake dragonflies fairly swarmed—usually out of reach of the collector. August 1st was spent along the Goulais River above Searchmont, and at the mouth of Achigan Brook. August 5th was spent along the Algoma Central as far as the inland terminus. Rain and cloudy weather prevailed during the entire day and no dragonflies were collected. August 6th was spent along Achigan Brook for several miles above Searchmont. Achigan Brook flows from Spruce Lake. It is known also as Spruce Creek and Little Goulais. I have never followed a more beautiful stream than this. Long, precipitous rapids, where great broken masses of rock impede the water, flinging it into a myriad of rainbows, alternate with serene slow-flowing pools, now broad, now narrow, in sunshine and shade. On August 7th I went on the tote-road to the third dam on Perry Brook, several miles from Searchmont ,and followed this stream till its clear waters mingled with the yellowish waters of the swift flowing Goulais. Along Perry Brook are great exposures of the clay mentioned above and of sand banks. August 8th was again spent along Achigan Brook several miles above Searchmont. On August 9th I walked south on the railroad three or four miles to where the railroad crosses Dam Creek. Dam Creek was explored for about a mile above the railroad and below the railroad to its mouth in the Goulais River. On my return trip home I stopped

at Oden, Crooked Lake, Michigan, with my uncle, G. T. Williamson, and August 11th and 12th, were spent collecting there. Later my cousin, Jesse H. Williamson, caught a few specimens about Oden. These records are mentioned in the lists which follow.

No birds or mammals were collected. The white-throated sparrows by their numbers and song were the conspicuous members of the avifauna. A small and exceedingly bold Buteo was frequently seen and heard. At lonely lakes, otherwise devoid of bird life, loons signaled my approach with their weird cries. Kingfishers rattled their displeasure or surpirse at my intrusion along their streams. Flocks of cross-bills* by their habits of flight and voice recalled the flocks of small parrots frequently seen in Central America. And in every thicket were numerous warblers unidentifiable to me without field glass or gun. About every lake and stream were innumerable dainty prints of deers' hoofs, with occasionally the ox-like spoor of the moose. Though an insect collector has small chance of surprising large game three fawns were seen. Beaver dams are common on the streams. On Dam Creek, in a distiiace of less than a quarter of a mile were three small newly constructed dams, built largely of yellow birch. Mr. J. L. Naylor of Searchmont told me that fisher, otter, mink and all the other furbearing animals of interior Canada are taken along the Algoma Central.

The following list of trees and bushes growing in the vicinity of Searchmont has been prepared for me by Mr Naylor: Pine, white, Jack and Norway, the last very scarce; spruce, balsam; tamarack; white cedar; hard maple; white birch, yellow (or red or black) birch; ironwood; popple or balm of gilead; red oak, very scarce; hemlock, very scarce; soft elm; cherry, very scarce; black ash; mountain ash; tag alder; elder (red berried); red currant; black currant, hazel; wild rose, two species of willow; choke cherries; ground hemlock; gooseberry; dogwood; raspberries; blackberries; blue berries.

PLANTS DETERMINED BY C. C. DEAM OF BLUFFTON, INDIANA.

Species preceded by a star (*) were taken at Searchmont, from August 6th to 10th. The other species were taken at Hayden, from July 31st to August 4th:

Pteridium aquilinum (L.) Kuhn.
Lycopodium lucidulum Michx.
L. obscurum L.
Sparganium androcladum (Engelm.) Morong.
*S. simplex Huds.
Potamogeton nuttallii Cham. & Sch.
Sporobolus asperifolius (N. & M.) Hurb.
Panicularia canadensis (Michx.) Kuntze.

*From my description of size, colors and habits, Mr. W. E. C. Todd has so determined them.

Scirpus cyperinus (L.) Kunth.
Eriophorum polystachyon L.
Rynchospora alba (L.) Vahl.
Carex abacta Bailey.
C. oligosperma Michx.
*C. retrorsa Schwein.
C. rostrata Stokes.
C. stellulata Gooden.
C. crawfordii Fernald
C. scoparia Schk.
Eriocaulon septenangulare With.
*Juncus nodosus L.
J. canadensis brevicaudata Engl
Streptopus amplexicaulis (L.) DC.
Pogonia ophioglossoides (L.) Ker.
Peramium ophiodes (Fernald) Rydb.
Brasenia purpurea (Michx.) Casp.
Castalia odorata (Dryand) W. & W.
Coptis trifolia (L.) Salisb.
Erysimum cheiranthoides L
Drosera intermedia Hayne
Amelanchier oligocarpa R. & S
Ilicoides mucronata (L.) Britton.
Hypericum ellipticum Hook
Triadenum virginicum (L.) Raf.
Cornus canadensis L.
Monotropa uniflora L.
Chamaenerion angustifolium (L.) Scop.
Lysimachia terrestris (L.) B. S. P.
Apocynum androsaemifolium L.
Scutellaria galericulata L.
Utricularia cornuta Michx.
*Viburnum opulus L.
Solidago rugosa Mill.
S. canadensis L.
Euthamia hirtella Greene.
Aster macrophyllus L. var. velutines Burgess.
*A. puniceus L.
A. nemoralis Ait.
*Doellingeria umbellata pubens (A. Gray) Britton.
Anaphalis margaritacea (L.) B. & H.
Achillea millefolium L.
Chrysanthemum leucanthemum L.
*Carduus muticus (Michx.) Pers.
*C. arvense (L.) Robs

BIVALVES.

At Heyden one species of bivalve was collected in the small stream connecting Mud Lake and the lake just above Mud Lake. Specimens were sent to the U. S. Nat. Museum and Mr. Rathbun reports that they have been determined as Anodonta marginata Say.

CRAYFISHES.

The crayfish collected on the trip were sent to Dr. A. E. Ortmann who furnishes the following report on them:

1. *Cambarus propinquus* Gir. Localities: Crooked Lake, Emmett County, Mich.; St. Marys River, Sault Ste. Marie; Algoma District, Inlet of Mud Lake, Heyden; Dam Creek, Searchmont.

The specimens are all typical.

Distribution: Drainage of Mississippi and lower Ohio, and of Great Lakes and St. Lawrence; in eastern Iowa, Illinois, Indiana, southern Wisconsin, Michigan, northern Ohio, northwestern Pennsylvania, western and northern New York, and eastern Ontaria (Toronto) and Quebec (Montreal). Up to the present time the last named locality (Montreal) and Oden, Emmett Co., Michigan, marked the most northern expansion of the range aside from the vague record "Lake Superior" given by Hagen (according to L. Agassiz). The present localities from the eartern extremity of Lake Superior (vicinity of Sault

Ste. Marie) tend to confirm this old record, although it has yet to be demonstrated that the species is found in Lake Superior proper.

2. *Cambarus virilis* Hagen. Locality: Crooked Lake, Oden, Emmett County, Michigan.

Distribution: Abundant in the Mississippi and Missouri drainage from northern Texas, Arkansas and Oklahoma, through Kansas, Missouri, eastern Nebraska, Iowa and western Illinois to Michigan and Minnesota. In the latter states, also in northern Indiana, it is found in the drainage of the Great Lakes. In northern Minnesota and north Dakota it has invaded the drainage of the Red River of the North, and goes through Winnipeg as far north as Saskatchewan (Hagen). It is also found in eastern Ontario, and the drainage of the lower lakes and the St. Lawrence, but not on the United States side: Toronto (Faxon); Sandy Lake, Peterborough County (Ortmann) and there is a fine series of this species in the Carnegie Museum from the new locality: Rideau River, Billings Bridge, Ottawa. This latter locality, Emmett Co., Michigan, and Lake Superior in Minnesota (Herrick) mark the northern boundary of this species in the Lake region. The absence of this species in the whole of the Ohio drainage is remarkable.

3. *Cambarus bartonii* (F.). Locality: Dam Creek, Searchmont, Algoma District, Ontario, Canada (region of eastern end of Lake Superior).

The specimens at hand agree in all essential points with the typical form of C bartonii as found in Pennsylvania; and also in minor points there is not the slightest difference; there is no approach whatever to C. bartonii robustus (Gir.).

Distribution: C. bartonii belongs to the Appalachian System, ranging from Tennessee and North Carolina to Maine and New Brunswick. Its northwestern boundary is formed by the St. Lawrence River and the lower lakes, it never having been reported, with one exception, to the north of this line This only exception is near Lake St. John, in Quebec, for to the northeast of the range in the States of Ohio and Indiana this species does not reach the Lake region and it has never been found in any part of Ontario, Michigan and Wisconsin.

Indeed Hagen gives, upon the authority of L. Agassiz: Lake Superior, a record that has been dropped by Ortmann (Trans. Am. Phil. Soc. 44 '05, p. 135). The present locality, however, confirms this old record, at least in so far as this species is positively found in the Lake Superior region. Nevertheless this locality appears strange since it is so far remote from the rest of the range, the nearest place, in western New York, being about 400 miles away. In the intervening region in eastern Ontario,

this species has not been found, although the variety robustus (Gir.) is found at Toronto and westward in tributaries of Lake Ontario.

Of course there must be a connection of our new locality with the main range of the species. It may go along the northern shore of Lake Huron and through eastern Ontario, but particulars are wanting. A connection through Michigan I think is out of the question, since this state as well as northern Indiana and northern Ohio are rather well known, so that we may safely affirm that it is missing in this region. Eastern Ontario is very poorly known. Thus this species should be searched for in Ontario and possibly also in southern Quebec.

One male, first form, two males, second form, and eight females of this species were taken under rocks in rapids in Dam Creek on August 9th. The specimens agree in size with specimens of the species from eastern Pennsylvania. One female was carrying recently hatched young. One male of C. propinquus was taken at the same place.

Reptiles and Batrachians.

But few reptiles were seen. The single turtle taken was the only one seen in Canada, and only two garter snakes were seen in the Algoma District, and one of these escaped. Frogs were exceedingly numerous at certain localities Rana catesbiana was very common at the lower end of Stony Lake where many could have been captured easily as they made but little effort to escape. The specimens collected were given to Dr. Atkinson who has prepared the following notes

1. *Rana pipiens* Schieber. Leopard Frog. This species is represented in the collection by five specimens, collected at Heyden, Ontario, Canada They are all small adults, the coloration of which is close to that described as Rana virescens brachycephala by Cope, having no longitudinal band on the femur and having the tibial cross bars complete, also yellow bordered dorsal spots. However, the head is longer than in typical specimens of the variety brachycephala, and the muzzle is as acuminate as in most specimens of the variety R. p. pipiens and the size of the spots correspond with the latter variety. The measurements in meters are as follows:

Length of head and body	.0464 to .0550
Length of head to posterior edge of tympanum	.0160 to .0195
Width of head at posterior edge of tympanum	.0155 to .0195
Diameter of tympanum	.0035 to .0045
Diameter of eye	.0050 to .0055
Length of tibia	.0255 to .0315
Length of femur	.0220 to .0260
Length of foot	.0260 to .0315

2. *Rana palustris* Le Conte. Pickerel Frog. There was one specimen of this species in the collection. It was taken at Heyden, Ontario, Canada, and differs in no way from western Pennsylvania specimens of this species. The measurements in meters are as follows:

Length of head and body	.0585
Length of head to posterior edge of tympanum	0195
Width of head at posterior edge of tympanum	.0205
Diameter of tympanum	.0045
Diameter of eye	.0055
Length of tibia	.0340
Length of femur	.0295
Length of foot and tarsus	.0250

3. *Rana septentrionalis* Baird. There were four specimens of this frog, all taken at Heyden, Ontario. Three are males and one a female. Measurements in meters:

Specimen No.	Lg. of head & body	Lg of femur	Lg of tibia	Lg. of ft. and tarsus	Eye	Tym-panum	Width of head
No. 1 male	.0655	.0315	0345	0350	0070	0080	0245
No. 2 male	0635	0315	0330	0355	0070	0075	.0240
No. 3 male	0665	0305	0335	0355	0075	0100	.0260
No. 4 female	0700	0305	0340	0360	0075	.0060	.0255

No. 1 has a very pale coloration; the vermiculations are scarcely visible; snout obtuse; no cross bars on the hind legs.

No. 2 has a very dark coloration; markings indistinct; snout medium obtuse; faint cross bars on the hind legs.

No. 3 has a bright coloration; markings distinct and of small pattern; snout sharply pointed; distinct cross bars on hind legs.

No. 4 has bright coloration; markings large and distinct; snout sharply pointed; distinct cross bars on the hind legs.

The coloration of these four specimens varies greatly, also the size of the tympanum and form of snout.

The skin of the back is smooth anteriorly, but becomes rough and tuberculated posteriorly and on the sides; belly entirely smooth. Cope says "The present distribution of the species is entirely northern" and he includes it in a list of batrachia typical of the Canadian fauna. It has been taken in the upper Michigan Peninsula, and the writer took it at Vanceboro, Maine, during May, 1901, where it was abundant.

4. *Rana catesbiana* Shaw. Bull Frog. There was one small adult and two young of this species in the collection. The coloration of these specimens is dark, but not more so than some Pennsylvania specimens, neither is the dorsal surface more nodular.

Measurements in Meters.	1. Juv.	2. Juv.	Adult
Length of head and body	.0360	.0830	.1115
Width of head	.0145	.0330	.0485
Length of femur	.0165	.0415	.0485
Length of tibia	.0125	.0420	.0545
Length of foot and tarsus	.0200	.0470	.0590
Diameter of eye	.0040	.0090	.0105
Diameter of tympanum	.0035	.0090	.0105
Length of fore-arm	.0075	.0190	.0245

5. *Rana sylvatica* LeConte. Wood Frog. The single specimen of this species in the collection was taken at Searchmont, Ontario, Canada, August 8, 1906. In this specimen the heel just reaches the anterior border of the orbit and the leg bars are very faint, two points in the direction of Rana cantabrigensis. However, it has as well developed an outer metatarsal tubercle as most specimens of Rana sylvatica, and the webbing on the feet and general coloration is that of this species. It is tuberculated posteriorly on the back, but smooth in front; below it is finely granulated to the abdominal and pubic regions; no light line along the thighs and two phalanges of the 4th toe free.

Measurements in Meters,	
Length of head and body	0505
Width of head	.0165
Length of femur	.0240
Length of tibia	0245
Length of foot	0250
Diameter of eye	.0050
Diameter of tympanum	.0035

6. *Bufo lentiginosus americanus* Le Conte. Common Toad. One specimen of this species collected at Heyden, Ontario, Canada, August, 1906. It is a typical B. l. americanus of dark coloration.

Measurements in Meters.	
Length of head and body	.0810
Width of head	.0325
Length of femur	.0350
Length of tibia	.0320
Length of tarsus	.0200
Diameter of tympanum	.0065
Diameter of eye	.0085
Length of leg	.1025

7. *Eutaenia sirtalis* Linn. Garter Snake. There were two specimens of this species; one (No. 16) from Searchmont, Ontario, Canada; collected August 8, 1906, and one (No. 17) from Oden, Michigan collected August 12, 1906. The Oden specimen is a typical E. sirtalis sirtalis in coloration; the Searchmont specimen is of the olive-green type of coloration that is found so commonly in the mountain region of Pennsylvania; light green dorsal stripe covering median dorsal row and half of each row on either side; a dark olive green stripe on either side extend-

ing to the third row of scales from the ventral plates; a light green stripe occupying the first three rows above the ventrals. Belly yellowish green, with faint spots on the ends of the gastrosteges.

MEASUREMENTS IN METERS.

Length (body and tail)	.5450	.5100
Length of tail	.1300	.1250
Upper labials	7	7
Lower labials	10 symmetrical	10 non-symmetrical
Gastrosteges	154	149
Sub-caudals	74 pairs	79 pairs

8. *Clemmys insculptus* Le Conte. Wood Turtle. One large specimen of this species collected at Searchmont, Ontario, Canada; August 8, 1906. The jaw is more prominently toothed than usual in this species; male measurements:

Length of carapace	2120
Width of carapace	.1525
Length of head	.0545
Width of head	.0375

ORTHOPTERA.

In so far as special attention was given to dragonflies I have reserved the final place in this paper for considering them. The few insects of other orders collected will be listed first.

The Orthoptera, determined by W. S. Blatchley.

1. *Circotittix verruculatis* (Kirby). Heyden, July 31st, 1 pair; Searchmont, August 6th and 8th, 3 males.
2. *Melanoplus bivittatus* (Say). Searchmont, August 7th, 1 male.
3. *Melanoplus atlanis* (Riley). Heyden, July 31st, male; Searchmont, August 6th and 7th, 1 male, 2 females.
4. *Melanoplus femur-rubrum* (DeG.). Searchmont, August 7th, 1 female.
5. *Melanoplus extremus* (Walker). Stony Lake, Heyden, August 3d, 2 males, 1 female.
6. *Stenobothrus curtipennis* (Harris). Searchmont, August 6th, 1 female.

The six species are known to occur in southern Canada and also all but Circotettix verruculatis occur in Indiana.

HEMIPTERA.

Where the overflow from Stony Lake descends rapidly to Mud Lake the course of the small stream is a succession of water falls and steep and high walled pools. In one of these dark pools a number of water skippers were collected. They were sent to Mr. J. R. de le Torre Bueno who has determined them as Gerris remigis Say, adults and nymphs. The other Hemiptera were sent to Professor H. Osborn, who names them as follows:

Ceresa melanogaster Osb , Searchmont.
Lepyronia 4-angularis Say, Searchmont.
Philaronia abjecta Uhl., Searchmont.
Diedrocephala coccinea Forst., Searchmont.
Helochara communis Fh., Heyden.
Draculaecephala mollipes Say, Searchmont.
Draculaecephala manitobiana Ball, Oden, Mich.
Gypona octolineata Say, Searchmont.
Thamnotettix melanogaster Prov., Oden, Mich.
Phlepsius apertus Van D., Heyden and Searchmont.
Platymetopius acutus Say, Searchmont.
Searchmont.

BUTTERFLIES.

So little time was spent away from the immediate vicinity of lakes and streams (in fact most of my time was spent *in* the lakes and streams) that the number taken of such conspicuous insects as butterflies is not large. These were sent to Mr. J. L. Graf of Pittsburg.

Anosia plexippus L., Searchmont, Hayden; one specimen seen but not taken.
Argynnis atlantis Edwards, Searchmont, Hayden.
Argynnis cybele Fab , Heyden, three females; one of these was submitted to Dr Skinner. See Entomological News, Vol. 4, 1893, p 318
Brenthis myrina Cramer, Searchmont, Hayden.
Pyrameis atalanta Linnaeus, Searchmont, one seen but not taken.
Grapta faunus Edwards, Searchmont, Hayden.
Vanessa J-album Boisduval and Leconte, Searchmont, Hayden
Vanessa milberti Godart, Searchmont.
Vanessa antiopa Linnaeus, Searchmont.
Basilarchia arthemis Drury, Hayden.
Pieris napi form virginiensis Edwards, Searchmont.
Colias eurytheme Bdv , Searchmont.

DIPTERA.

The Diptera, exclusive of Syrphidae, were sent to Professor Jas. S. Hine and the Syrphidae were sent to Professor R. C. Osburn. Their lists follow

The following eighteen species of Diptera are all well known, with the exception of what I have called Laphria terraenovae. Macquart described this species from specimens taken in Newfoundland and it appears that it has not been recognized since. His description is very short and consequently it is with some doubt that the specimens before me are given the name, but the points mentioned agree so well that I know of no good reason why they might not be of the species in question.

The collection contains the finest series of Chrysops excitans Walker that I have ever seen. This species is not rare, but its habitat is in such high latitudes that specimens are not often taken. Over twenty specimens were taken at Heyden, Ontario, August 6th.

Physocephala furcillata Williston is a notable species of the family Conopidae. It appears to be strictly northern in its distribution.

It is interesting to note that just half of the species have blood-sucking females, while at least four are parasitic and two are predaceous.

Following is a full list of species exclusive of the Syrphidae:

Simuliun venustum Say, Heyden.
Stratiomyia badius Walker, Searchmont.
Chrysops carbonarius Walker, Searchmont.
Chrysops excitans Walker, Heyden.
Chrysops frigidus Osten Sacken, Searchmont.
Chrysops niger Macquart, Heyden.
Chrysops striatus Osten Sacken, Oden, Michigan.
Tabanus microcephalus Osten Sacken, Heyden.
Tabanus nivosus Oster Sacken, Heyden.
Spogostylum pluto Wied , Heyden.
Anthrax lateralis Say, Searchmont.
Laphria terrae-novae Macquart, Heyden.
Promachus bastardii Macquart, Heyden.
Physacephala furcillata Will., Oden, Michigan.
Echinomyia algens Wied., Sault Ste. Marie.
Echinomyia decisa Walker, Oden, Michigan.
Panzeria radicum Fabr., Oden, Michigan.
Phortica alboguttata Wahl Searchmont.

SYRPHIDAE, by Dr. R. C. Osburn.

Syrphus ribesii (Linne). Heyden and Searchmont.
grossulariae Meigen. Heyden and Searchmont.
Sphaerophoria cylindrica (Say), Searchmont.
Sericomyia militaris Walker. Heyden and Searchmont.
Eristalis tenax (Linne). Searchmont.
meigenii Wiedemann. Soo.
bastardi Macquart. Oden, Mich
flavipes Walker. Heyden and Searchmont, Oden, Mich.
transversus Wiedemann. Heyden.
Helophilus similis Macquart. Oden, Mich.
chrysostomus (Wiedemann). Oden, Mich.
conostomus Williston. Heyden.
Mallota cimbiciformis (Fallen). Heyden.
Temnostoma aequalis Loew. Heyden.

The above list of Syrphidae is a rather characteristic late summer list, and all the species are fairly common except the last which deserves some mention. Temnostoma aequalis has been recorded from three widely separated localiites, the White Mountains, the English River of Hudson's Bay Terr. and Colorado,* but can byno means be considered a common species. In ten years of collecting in Ohio, N. Dakota, Br. Columbia, N. Y., and Mass., the writer has not met with it. The present record is

* In writing the above I overlooked the fact that the species has been recently recorded for Minnesota (by name only). Tenth Ann. Rep't State Entomologist of Minn., Dec., 1905, by. F. L. Washburn.

interesting in being about intermediate in location to the previous records. The specimen, a female, is considerably brighter in coloration than Loew's and Williston's descriptions indicate, and there is no black on the hind femora as described by Loew "femoribus praeter apicem nigris" (Centur. V. 36). Otherwise the description applies closely.

COLEOPTERA.

The Coleoptera were sent to Mr Chas. Dury of Cincinnati, who has furnished me with the following list

Cicindela longilabris Say
  vulgaris Say
  var obliquata Kby
  hirticollis Say
Gyrinus limbatus Say
  dichrous Say
  canadensis Reg
Nechrophorus vespilloides Hbst
Coccinella trifasciata Linn
Buprestis fasciata Fabr
  maculiventris Say
Ellychnia corrusca Linn
Leptura canadensis Fabr
  proxina Say
Monohammus confusor Kby
  scutellatus Say.
Doryphora 10-lineata Say
Chrysomela spiraeae Say
Adoxus vitis Linn

The Adoxus are very small specimens of this species, otherwise the collection does not present any noteworthy features, unless it be to emphasize the fact, that Coleopterous insects are scarce in this region at this season of the year

HYMENOPTERA.

The Hymenoptera were sent to Professor Jas. S. Hine who submits the following notes and list:

Three of the species have been determined by C. T. Brues of the Milwaukee Public Museum Of a species of the family Evaniidae, taken at Searchmont, August 6th, he says that it is either Gasteruption kreichbaumeri Schletterer, described from Europe, or a new species. The following species besides the one mentioned were taken:

Urocerus albicornis Fabr, Heyden.
Homotropus pallipennis Prov, Searchmont.
Exoclium mundum Say, Oden, Michigan
Exoclium fascipenne Norton, Searchmont.
Rhyssa albomaculata Cresson, Oden, Michigan.
Eumenes fraternus Say, Searchmont, Ontario.
Odynarus sp., Searchmont.
Pryonyx atratus Lep., Heyden.
Bombus ternarius Say, Searchmont

DRAGONFLIES.

As before stated almost my entire attienton was given to dragonflies. A list of those taken follows:

1. **Calopteryx maculata** Beauv. Heyden, July 31st; outlet Stony Lake, August 4th; Searchmont, Aug. 1, 6, 7 and 9th. Altogether 9 males and 4 females. Much commoner than the next.

2. **Calopteryx aequabilis** Say. Heyden, July 31st and Aug. 3d; Searchmont, Aug. 1st. Four males and two females. More wary and swifter of flight than maculata.

3. **Lestes congener** Hagen. Searchmont, Aug. 7th; 4 males, 1 female, all taken in a small area of timothy growing in a bend of Perry Brook.

4. **Lestes uncatus** Kirby. Heyden, July 31st; Searchmont, Aug. 6th; 7 males and 3 females.

5. **Lestes disjunctus** Selys. Heyden, July 30th, Searchmont, Aug. 1, 6, 7 and 8th; Oden, Mich., Aug. 11th. Fifty males and four females were taken. Near Searchmont, along the railroad track, is a small marsh, grown up with a narrow, soft leaved sedge where this species was very abundant.

6. **Lestes rectangularis** Say. Sault Ste. Marie, July 29th; Oden, Michigan, Aug. 12th, three males.

7. **Chromagrion conditum** Hagen Stony Lake, Aug 3d and 4th. Six males and one female.

8. **Nehalennia irene** Hagen. Stony Lake, Aug. 3d. One male.

9. **Enallagma hageni** Walsh. Heyden and Stony Lake, July 30th and Aug. 3d and 4th. Eighteen males and one female.

Enallagma ebrium Hagen, Oden, Michigan, Aug. 11th. One male.

Enallagma carunculatum Morse. Oden, Mich , Aug 11th and 13th. J. H. Williamson. Four males.

Enallagma exsulans Hagen. Oden, Mich. Aug. 13th J. H. Williamson. Three males.

Enallagma signatum Hagen. Oden, Mich. Aug. 13th J. H. Williamson. A pair.

10. **Ischnura verticalis** Say. Stony Lake, August 3d, Oden, Mich. Aug. 13th and 24th. J. H. Williamson. Two males and two females.

11. **Ophiogomphus carolus** Needham. Heyden, July 31st, Searchmont, Aug. 1, 6, 7 and 8th. Sixteen males and two females. Only two males were taken along Root River and but one or two more were seen there. The others were all taken along tributaries of the Goulais. A few were seen along the Goulais itself but were not taken. From its resting place on the leaves of the alder or from high in some tree this dragonfly makes fre-

quent but short visits to the rapids of the stream where its nymphal life was passed. With swift flight it drops from its sunlit leaf to a boulder, log or bit of smooth sand. It moves from one station to another by short flights, rendered invisible to the collector because of its swiftness and the agitated waters over which the insect passes. After a few moves it throws itself boldly into the water from which it arises to seek again its leafy and frequently lofty perch. When the late afternoon sun bathes with vertical rays a leafy wall of vegetation on the edge of some swift ripple where the crane flies are dancing in the spray, carolus forgets the heights of forest trees and catching its prey with ease, feeds and basks on a swaying leaf, from which it springs to flit the ripple and return again. The sun sinks lower, the forest shadow creeps across the ripple and up the alders, and the green mite of most animate nature rises with the shadow into the safe retreat of forest trees.

12. **Gomphus sordidus** Hagen. Heyden, July 31st, one female. Along Root River at different ripples on two occasions I saw males of a species of Gomphus which I thought was brevis. The abdomen was colored and held aloft exactly like this species. Also along Root River I saw close at hand a female Gomphus which I believe was exilis.

13. **Gomphus scudderi** Selys. Searchmont, Aug. 1, 6, 7, 8 and 9th. Fifty-two males; no females were seen; along the Goulais and its tributaries this was the commonest dragonfly. When resting on smooth sand, boulders or logs it is approached with difficulty; when resting on vegetation it may usually be taken with ease. It is a restless busy body, its flight swift but not well balanced or long sustained. One on occasion one flew swiftly toward me and alighted on my shoulder. A slight motion on my part caused it to take to sudden flight. On another occasion one alighted on the back of one hand. The other hand was brought slowly and carefully up and a fore and hind wing seized between thumb and finger. Several males of this species were distinctly seen at Oden, Mich., but were not captured.

Dromogomphus spinosus Selys. Oden Mich. Aug. 14th. J. H. Williamson. One male.

14. **Lanthus albistylus** Hagen. Searchmont, Aug. 8th; two males. This species was also distinctly seen at a ripple in Root River, but no specimens were taken there. The two taken were at the same ripple at Achigan Brook where one or two more were seen. No other specimens than these mentioned were seen during the trip.

15. **Hagenius brevistylus** Selys. Heyden, July 31st and Aug. 2d; Searchmont, Aug. 8th. Four males and one female. One male taken Aug. 8th was the only individual seen in the

Goulais drainage. Several were seen at Oden but none were captured there. The great bulk of this dragonfly and its peculiar flight, with its abdomen curved as though it would bring the center of gravity forward more nearly under the wing bases, are distinctive.

16. **Cordulegaster maculatus** Selys. Heyden, Aug. 2d; Searchmont, Aug. 1, 6 and 9th. Nine males and three males. These specimens are larger than others I have seen. At Heyden two females were taken and these were observed to fly down from trees alighting on algae covered rocks in the stream bed. On the portions of these rocks not covered with water they crawled about in an awkward, almost crippled, manner thrusting the abdomen with much commotion into the algae beneath the water. Males at Heyden alternated between the trees and short flights over the water. At Dam Creek, where six males were taken during the forenoon, the stretch of water patroled was greater and the dragonflies were not interrupting their flight by frequently alighting in trees. The single female taken along Dam Creek alternated short flights with rests on low shrubs growing on the stream's banks. On July 31st another species of Cordulegaster was seen near a small much-shaded spring which discharged a small volume of water into the creek which I followed that day to its mouth in Root River.

17. **Boyeria vinosa** Say. Heyden, July 31st and Aug. 2d and 3d; Searchmont, Aug. 6, 7, 8 and 9th. Twenty-four males and one female. A common species along the streams where its tendency to examine critically every object projecting above the water often makes its capture an embarrassing matter to the collector. More than once as I waited for an approaching male that insect suddenly left the line of flight I had mapped out for it, flew to within an inch of my legs, circled around one leg a time or two, then about the other, then about both, and then quietly resumed its flight along the stream, oblivious to the net which had been frantically fanned all around it. Along Root River a portion of a fallen bridge lay in the stream forming a dark recess a few inches high, six or eight feet wide and possibly ten deep, over the water. One end of this recess ended in the bank, the only open side being directed toward mid-stream. I saw many Boyerias fly along the stream at this point and without exception all flew back into this recess, where they were completely concealed from the collector. Some of them remained within only a few seconds while others were there possibly a full half-minute. This species is more crepuscular than any other North American Aeshnine known to me.

18. **Boyeria grafiana** Williamson. Heyden, Aug. 2d; Searchmont, Aug. 6, 8 and 9th.

Note on Aeshnas. The main purpose of this collecting trip was to study the Aeshnas of the region in life. I believe that in the material collected by myself four species are represented. This belief is based however, largely on opinions formed in the field and not on study of the material after my return. This study will be made by Prof. E. M. Walker to whom I have sent my entire collection. Professor Walker's study will not be completed in the immediate future and for my purposes in this paper I have listed the species under four letters. Representatives of these four species, as I understand them, have been sent to Dr. Calvert for examination, and his notes on male abdominal appendages follow. But as I understand it, Dr. Calvert's opinions on these species are tentative, and the demands on his time permit no particular study of this matter now. So the question of the status of the four forms here indicated now rests with Professor Walker, to whom as stated, I have sent the entire lot.

Dorsal thoracic stripes short and narrow; lateral thoracic stripes divided each into two spots. Male anal triangle two-celled; appendages juncea type (intermediate between clepsydra, typical, and eremita—Dr. Calvert). Female appendages longer than the male, narrow, apex rounded. Aeshna W.

Dorsal thoracic stripes short and narrow, lateral thoracic stripes not divided; first lateral stripe wider below; size large. Male anal triangle two-celled; appendages juncea type (eremita form of appendages—Dr. Calvert). Female appendages about equal to male appendages, apex rounded Aeshna X.

Dorsal thoracic stripes wide, reaching antealar sinus where they are widened; lateral thoracic stripes not divided; first lateral stripe wider below, size smaller than Aeshna X. Male anal triangle two-celled; appendages juncea type (clepsydra, typical, form of appendages—Dr. Calvert). Female appendages shorter, apex rounded. Aeshna Y.

Dorsal thoracic stripes wide, reaching antealar sinus where they are widened; lateral thoracic stripes not divided, about equal and uniform in width; abdomen with the blue spots greatly reduced in size. Male anal triangle three-celled; appendages cyanea type. Female appendages slightly longer than the male, apex rounded. This species has been widely listed as constricta. Aeshna Z.

19. **Aeshna W.** Heyden, July 30th and 31st, and Aug. 2, 3 and 4th. Searchmont, Aug. 6 and 9th. Eleven males and six females. On the afternoon and about sunset of Aug. 3d there were heavy showers of rain accompanied by thunder and lightning at Heyden. The yard of the shingle mill is devoid of all vegetation. Many shallow pools which disappeared before the next morning were formed in the yard. After sunset the rain ceased and almost at once dragonflies began to appear about

these pools. They were visible only when seen against the water and not always then. As long as sufficient light remained to catch glimpses of them they were still on the wing in apparently undiminished numbers. I succeeded in taking only eight specimens. One of these was Boyeria vinosa. The others were Aeshnas—W, Y, and Z. All eight were males.

20. **Aeshna X.** Heyden, July 30 and 31st, and Aug. 2d, 3d and 4th. Searchmont, Aug. 1 and 7th. Twenty-one males and four females. Most of this material was taken at Stony Lake. Only two specimens were taken at Searchmont. This was to be expected since, as stated above, all the collecting I did at lakes was done in the vicinity of Heyden, while at Searchmont rapid streams were followed, along whose courses Aeshnas and others, such as Leucorhinias, could be expected only as accidental visitors.

21. **Aeshna Y.** Heyden, July 30th, and Aug. 3d and 4th. Searchmont, Aug. 1 and 9th, Oden, Michigan, Aug. 11th and 12th, and Aug. 24th, (J. H. Williamson). Twenty-seven males and two females. Nineteen of these males were taken at Oden. Aeshna X was not seen at Oden at all. Aeshna Y was rare about Heyden, but, associated with a few Aeshna Z, it made up the entire Aeshna fauna, so far as I could determine, at Oden on the dates I was there.

22. **Aeshna Z.** Heyden, July 30th and Aug. 2, 3 and 4th. Searchmont, Aug. 6th; Oden, Michigan, Aug. 11th and 15th (J. H. Williamson). Twenty males and two females. This is the only Aeshna known to me which prefers woodland pools, quiet, grass-grown and much shaded streams, and early morning and late afternoon for its greatest activity. Of course it may be taken under other conditions but under these the most individuals are seen and taken. The species was the one usually taken along Root River. Two individuals were taken at Searchmont and three at Oden. Three females Aeshnas taken at Oden are not listed in the above discussion. These were taken Aug. 11th and Aug. 23d and Sept. 3d (J. H. Williamson).

23. **Somatochlora elongata** Scudder. Heyden, July 30th and 31st, and Aug. 2 and 3d. Seventeen males. When not hawking at a considerable elevation this species was readily taken. I believe the Somatcohloras possibly enjoy a reputation for more powerful flight than they really possess. A wary dragonfly with just sufficient powers of flight to maintain itself in the air at an elevation beyond the reach of the collector would be difficult to capture. Moreover, if it were rare and seldom met with, the collector's anxiety to capture every specimen seen would tend to magnify his opinion of its powers. In the case of S. elongata the flight is not as sustained as that of the Aeshnas, it is less adept at dodging the collector's net, and it lacks the dash and mobility of

some of the Libellulines such as Libellula incesta and Plathemis lydia. Another species of Somatochlora was taken along Achigan Brook, but unfortunately it was broken into fragments by the ring of the insect net, rendering identification at the time impossible, and the fragments were subsequently lost.

Somatochlora williamsoni Walker. Oden, Michigan, Aug. 11th. Two males; I have in my collection a male of this species collected by M. K. Williamson at Oden, on Aug. 14, 1904.

24. **Cordulia shurtleffi** Scudder. Stony Lake, Aug. 3d. A single teneral male taken.

25. **Dorocordulia libera** Selys. Stony Lake, Aug. 3d, a single male which frequented a small area of water, floating logs and fallen tree tops.

26. **Leucorhinia frigida** Hagen. Stony Lake, Aug. 3d and 4th. Two males and two females. Associated with the next two species at Stony Lake. The three species were frequently found resting on all possible supports a short distance from the water and over the water a short distance from the shore, about the pond-like lower end of the lake. Frigida seemed to prefer, however, the dead twigs of fallen tree tops lying in the water some distance from the shore.

27. **Leucorhinia proxina** Calvert. Heyden, July 31st and Aug. 3d and 4th, Searchmont, Aug. 6th. Twenty males and fifteen females. All of these excepting three females, two taken July 31st and one Aug. 6th, were taken at Stony Lake. One of these males I at first thought represented another species, because of the following characters: the basal branch of the hamule is bent down on the hamule; the triangle of the front wing is followed by three cells, then three, then increasing; and the labium is varied with pale areas. The specimen was referred to Dr. Calvert who called my attention to Hagen's notes on the folding of the basal branch of the hamule (Syn. Od. Genus Leucorhinia, pp. 229–236, Trans. Am. Ent. Soc. XVII, July, 1890). Also a tabulation of venational characters of specimens in Dr. Calvert's collection shows that proxima has the triangle of the front wing followed by three rows of cells, increasing, or by three rows, then two, then increasing. Moreover, there is considerable variation in the color of the labium in this species.

28. **Leucorhinia glacialis** Hagen. Stony Lake, Aug. 3d and 4th. Five males. One male has the lower basal cell in both hind wings twice crossed.

29. **Leucorhinia intacta** Hagen. Sault Ste. Marie, Ontario, July 29th. One female.

30. **Sympetrum obtrusum** Hagen. Sault Ste. Marie, Ontario, July 29th and 30th. Heyden, July 30th and 31st and Aug. 3d. Searchmont, Aug. 1, 6 and 8th. Oden, Mich. Aug. 11th and 12th, and Aug. 14th and 26th (J. H Williamson). Forty males and six

females were taken of this very abundant species. There is a disposition to regard rubicundulum and obtrusum as scarcely distinct. I have examined a great amount of material, covering practically the total range of the two and I have never seen a specimen which could not be referred certainly to one or the other on the basis of form of accessory genitalia of segment two. Moreover, the ivory white face of mature obtrusum is in striking contrast with the obscure face of rubicundulum. On the other hand I do not regard assimilatum as worthy of a name. At Stony Lake this species was very abundant, associated with the three species of Leucorhinia. What is the significance of the ivory face of the four?

31. **Sympetrum scoticum** Donovan. Sault Ste. Marie, Ontario, July 30th. A single female; others were seen but I had but a moment during a stop of the train.

32. **Libellula quadrimaculata** Linné. Stony Lake, August 3d, three males. This species was common at Stony Lake, resting on dead twigs over the water It was seen at a number of places along the railroad track in the Upper Peninsula of Michigan.

LIST OF DRAGONFLIES OF CANADA.

E B Williamson

The following papers published within the past few years repeat most of the records of earlier authors and throw new light on the distribution of northern North American dragonflies. In addition to the species discussed in these recent papers and listed below the following have been recorded from Canada·

Cordulegaster sayi, Samatochlora franklini, Somatochlora septentrionalis, Dorocordulia lintneri, Celithemis fasciata, and Leucorhinia borealis.

The portion of this vast land area west of the continental divide is characterized among other features by the development of the genus Sympetrum. The eastern portion, of much greater extent, is characterized by a richer fauna and the great number of Gomphines and of species of the genus Somatochlora.* Yet the homogeneity of the fauna of the entire region, east and west, is strikingly indicated by a comparison of the lists of species known from Alaska and Newfoundland. The ten certainly determined species known from Alaska are widely distributed and, with the exception of one, Aeshna constricta, itself a very common, widely distributed species, all are known to occur in Newfoundland. Where homogeneity in the east and west regions

* So few specimens have been taken that it is possible many of the eastern species of Somatochlora may eventually be found on the western coast also.

is lacking it may be explained probably by the migration of southern species northward, either along the Pacific Coast region or over the broad continental land mass east of the divide, and the inability of many of these forms to cross the divide. For examples of species unable to cross this barrier see the genus Argia, Ischnura, Gomphus, and Sympetrum. Boreal species which range freely across the continent are Cordulia shurtleffi, Leucorhinia hudsonica, etc.

1. Notes on Nova Scotian Dragonflies by P. P. Calvert and William Sheraton. Can. Ent. Nov., 1894, pp. 317–320.

2. Papers from the Harriman Alaska Expedition, XXII, Ent. Results (14) Odonata, by R. P. Currie, Proc. Wash. Acad. Sci. Vol. III, pp. 217–223, 1901.

3. Dragonflies from the Kootenay District of British Columbia, by R. P. Currie, Proc. Ent. Soc. Wash. Vol. VII, No. 1, 1905, pp. 16–20.

4. The dragonflies of the Province of Quebec, by Rev. T. W. Fyles, 31 annual report of the Ent. Soc. of Ontario, 1900, pp. 52–55.

5. The Odonata of British Columbia, by R. C. Osburn, Ent. News, June, 1905, pp. 184–196.

6. Orthoptera and Odonata from Algonquin Park, Ontario, by E. M. Walker, 36 annual report of the Ent. Soc. of Ontario, 1905, pp. 64-70.

7. A first list of Ontario Odonata by E. M. Walker. Can. Ent. Vol. XXXVIII, April, 1906, pp. 105–110, May 1906, pp. 149–154.

8. A new Somatochlora with a note on Ontario species by E. M. Walker, Can. Ent. Vol. XXXIX, March, 1907, pp. 69–74.

9. Dragonflies from the Magdalen Islands, by E. B. Williamson, Ent. News, May, 1902, pp. 144–146.

10. Dragonflies collected by Dr. D. A. Atkinson in New Foundland with notes on some species of Somatochlora, by E. B. Williamson, Ent. News, April, 1906, pp. 133–139.

In the following list of species the numbers refer to the papers above correspondingly numbered. The number 11 refers to my Algoma District list above enumerated:

Calopteryx maculata Beauv. 4, 6, 7, 11
C aequabilis Say 4, 6, 7, 11
Lestes congener Hagen 3, 5, 6, 7, 11
L. unguiculatus Hagen 1, 4, 7
L. uncatus Kirby 1, 3, 5, 6,7,11
L. disjunctus Selys 1, 6, 7, 11
L. forcipatus Rambur 3, 5
L. rectangularis Say 6, 7, 11
L. vigilax Hagen 7
Argia putrida Hagen 6, 7
A. apicalis Say 7
A. violacea Hagen 6, 7
A. vivida Selys 5
Chromagrion conditum Hagen 7, 11
Nehalennia irene Hagen 7, 11
Amphiagrion saucium Burm. 4, 5, 7
Enallagma hageni Walsh 4, 6, 7, 9, 11
E. cyathigerum Charpentier 2, 3, 5, 9, 10

E. calverti Morse 2, 3, 5, 7, 10 (in 10 reasons are given for considering calverti a synonym of boreale Selys).
E. ebrium Hagen 1, 6, 7, 10
E. durum Hagen 4
E. carunculatum Morse 3, 5, 7
E. civile Hagen 4
E. geminatum Kellicott 7
E. exsulans Hagen 6, 7
E. signatum Hagen 7
E. antennatum Say 7
Agrion resolutum Hagen 7, 9
Ischnura posita Hagen 4
I. ramburii Selys 4, 7
I. verticalis Say 6, 7, 11
I. cervula Selys 3, 5
I. perparva Selys 5
I. erratica Calvert 5
Ophiogomphus occidentis Hagen 5
O. rupinsulensis Walsh 4, 6, 7
O. colubrinus Selys 4
O. carolus Needham 11
Gomphus brevis Hagen 6, 7
G. confraternus Selys. 5
G. borealis Needham 7
G. exilis Selys 4, 6, 7
G. sordidus Hagen 7, 11
G spicatus Hagen 7
G. furcifer Hagen 7
G villosipes Selys 7
G. fraternus Say 4
G. crassus Hagen 7
G. vastus Walsh 4
G. scudderi Selys 6, 7, 11
G. plagiatus Selys 6, 7
G. notatus Rambur 4
Dromogomphus spinosus Selys 4, 7
Lanthus albistylus Hagen 6, 7, 11
L. parvulus Selys 1
Hagenius brevistylus Selys 6, 7, 11
Cordulegaster dorsalis Hagen 5
C. obliquus Say 4, 7
C. maculatus Selys 1, 7. 11
C. diastatops Selys, 1, 4, 7
Tachopteryx thoreyi Hagen 4
Boyeria vinosa Say 4, 6, 7, 11
B. grafiana Williamson 11
Basiaeschna janata Say 4
Aeshna juncea Linne 2, 3, 5, 9
A. verticalis Hagen 4, 6, 7
A. californica Calvert 5
A. clepsydra Say 1, 2, 6, 7, 10
A. sitchensis Hagen 2, 10
A. septentrionalis Burm. 4, 10
A. constricta Say 1, 2, 3, 4, 5, 6, 7
A. multicolar Hagen 3, 5
Epiaeschna heros Fabricius 4, 7
Anax junius Drury 4, 7

Bluffton, Indiana.

Macromia illinoiensis Walsh 4, 6, 7
Didymops transversa Say 4, 6, 7
Neurocordulia yamaskanensis Prov. 4, 7
Epicordulia princeps Hagen 4, 6, 7
Tetragoneuria spinigera Selys 5, 6,7
T. cynosura Say 4, 6, 7
T. semiaquea Burmeister 1, 6, 7
Helocordulia uhleri Selys 4, 6, 7
Somatochlora semicircularis Selys 3, 5
S. forcipata Scudder 1, 4, 6, 7, 8, 10
S. elongata Scudder 1, 4, 6, 7, 8, 11
S. williamsoni Walker 8
S. walshii Scudder 1, 8
S. linearis Hagen 4
S. hudsonica Hagen 10
S. albicincta Burmeister 2, 4, 10
S. cingulata Selys 10
S. tenebrosa Say 1, 7, 8
Cordulia shurtleffi Scudder 1, 2, 3, 5, 6, 7, 10, 11
Dorocordulia libera Selys 7, 11
Nannothemis bella Uhler 7
Celithemis eponina Drury 7
C. elisa Hagen 6, 7
Leucorhinia frigida Hagen 6, 7, 11
L. proxima Calvert 1, 3, 5, 11
L hudsonica Selys 1, 2, 3, 4, 5, 9, 10
L glacialis Hagen 1, 7, 11
L intacta Hagen 1, 4, 7, 11
Sympetrum illotum Hagen 5
S. rubicundulum Say 1, 3, 4, 5, 6, 7
S. vicinum Hagen 3, 5, 6, 7
S. pallipes Hagen 5
S obtrusum Hagen 1, 3, 5, 6, 7, 11
S. semicinctum Say 3, 5, 6, 7
S. scoticum Donovan 3, 4, 7, 11
S. costiferum Hagen 3, 5, 7, 10
S. madidum Hagen 5
S. illotum Hagen 5
S. corruptum Hagen 3, 5, 7
Pachydiplax longipennis Burmeister 5, 7
Erythemis simplicicollis Say 7
E. collocata Hagen 5
Erythrodiplax berenice Drury 7
Libellula quadrimaculata Linne 1, 2, 3, 4, 5, 7, 9, 10, 11
L. semifasciata Burmeister 7
L. basalis Say 7
L. incesta Hagen 7
L. forensis Hagen 5
L. pulchella Drury 4, 7
L. julia Uhler 5, 6, 7
L. exusta Say 4
Plathemis lydia Drury 4, 5, 7
Tramea carolina Linne 7

NOTES ON A COLLECTION OF BATRACHIANS AND REPTILES FROM CENTRAL AMERICA.

Dr. D. A. Atkinson.

It has been the privilege of the writer to look over a small collection of Batrachians and Reptiles made in Central America during January and February of 1905 by E. B. Williamson, Jas. S. Hine and Chas. Deam. There are seventy-two specimens in the collection, sixty-eight of which were collected in Guatemala, two in British Honduras, and two in Honduras.

Seven frog larvae and one young snake could not be determined specifically on account of their immaturity and the lack of descriptions of the young of the Central American species.

The eighteen specimens of Batrachians represent four genera and seven species (including the undetermined Rana sp.); the fifty-four specimens of Reptiles represent twelve genera and seventeen species. While none of the specimens present any great variations from the descriptions published, still there were a number of minor variations noted and recorded in the following notes. The known geographical range of several species is considerably extended by this collection. The measurements and some of the scale formulæ are given with most species of reptiles, as there is a lack of information along these lines.

BATRACHIA.

BUFO.

This genus is represented by six specimens, belonging to two species; all the specimens being adults except one.

(*a*) Bufo marinus (specimens No. 3 and 36). This is the large brackish water species, being one of the largest species of the genus, with very large and prominent parotid glands. No. 3 was collected at Gualan, Guatemala, Jan. 13, 1905; No. 36 was collected at Los Amates, Guatemala, Feb. 25, 1905. Both specimens are full grown and show the characteristic parotid development, but have much smoother skin than the specimens of the same species from the South American coast.

(*b*) Bufo valliceps. (Specimens No. 29, 51, 55, and 63.) No. 29, collected at Gualan, Guatemala, Jan. 16, 1905, is an adult specimen, typical coloration, and with very prominent tubercles for this species; No. 51 was collected at Los Amates, Guatemala, Feb. 25, 1905, adult specimen with very dark coloration; No. 55 was collected at Gualan, Guatemala, Jan. 13, 1905, adult, coloration and tubercles typical; No. 63, was collected at Gualan, Guatemala, January 13, 1905, and is a very young specimen, ¾ in. in length. The bony ridges on the head of No. 63 are very slightly developed, but the coloration and the tubercles are very similar to those of the adult.

HYLA.

This genus is represented in the collection by three specimens belonging to three species.

(*a*) Hyla nana, (specimen No. 62) was collected at Los Amates, Guatemala, January, 1905. It is a small adult specimen with a typical coloration and conforms closely to the description.

(*b*) Hyla taeniopus, (No. 52) was collected at Morales, Guatemala, March 8, 1905. It is an adult specimen which conforms to the anatomical descrpition, but presents a quite distinct coloration, lacking the line along the side and having only a few irregular spots on the back. Head markings fairly typical.

(*c*) Hyla quinquevittata (specimen No. 61) was collected at Los Amates, Guatemala, January, 1905. It is a small adult; the lines along the back are broken, giving it a spotted appearance

LEPTODACTYLUS.

Leptodactylus caliginosus, (specimens No. 60 and 70) were collected at Belize, British Honduras, January 9, 1905. Young specimens with typical markings.

REPTILIA.

CHELONIA, TURTLES.

CINOSTERNON.

Three turtles were in the collection, all belonging to this genus, but each one to a different species. Of the thirteen species of Cinosternon, nine are peculiar to Central America, according to Gunther.

(*a*) Cinosternon leucostòmum (specimen No. 37) adult ♂ collected at Los Amates, Guatemala, February 25, 1905. This is the most abundant of the Central American species of this genus, occurring in Mexico, Guatemala, Costa Rico, Panama, and Columbia. In this specimen the gular plate is longer than usual, and the markings on the head are more prominent than in several other specimens of this species which were examined; length 4½ in.

(*b*) Cinosternon brevigulare (specimen No. 71) adult ♂. Length 5½ in., collected at Puerto Cortez, Honduras, February, 1905. This specimen was sent back alive and is still living (Dec., 1905). It eats vegetable matter and spends most of its time in the water. The femoral plates are broader than normal in the specimen, giving an oval shape.

(*c*) Cinosternon cobanum, (specimen No. 72), adult ♂. Length 4¼ inches. Collected at Puerto Cortez, Honduras, February, 1905. This specimen was also received alive, eats meat entirely, and spends a considerable portion of its time out of water. Nuchal is very small, and there are but twenty-one marginals.

LACERTILIA, LIZARDS.

ANOLIS.

The collection contains two specimens of this genus, representing two species.

(*a*) Anolis godmani (specimen No. 26) collected at Gualan, Guatemala, January 25, 1905. Total length, 4⅝ in., length of body 1½ inches, of tail 3⅛ inches; markings very obscure.

(*b*) Anolis salvini (specimen No. 50) collected Los Amates, Guatemala, February 25, 1905. Total length, 4⅝ inches, length of body 1⅞ inches, of tail 2¾ inches.

CTENOSAURA.

The species of this genus are peculiar to Mexico and Central America; there was but one specimen of this genus in the collection.

(*a*) Ctenosaura complecta (specimen No. 53), adult ♂ Collected at Gualan, Guatemala, January 13, 1905. Length, 12½ inches, body 3⅞ inches, tail 8⅝ inches. Coloration bright, showing the cross bands distinctly, dorsal crest smaller than normal.

BASILISCUS.

This genus is separated from the following one by the presence of a free dermal border on the toes and the absence of femoral pores. It is represented in the collection by fifteen specimens of one species, Basiliscus vittatus. The measurements and peculiarities of these specimens are given under the specimen numbers as follows:

No. 1. Collected at Gualan, Guatemala, January 13, 1905. Length 12 inches, tail damaged, body 7 inches, crest large.

No. 2. Collected at Gualan, Guatemala, January 13, 1905. Length of body, 6¼ inches, tail broken. Coloration dull.

No 30. Collected at Gaulan, Guatemala, January 16, 1905. Length, 21½ inches, body 6 inches in length, tail 15½ inches.

No. 42. Gualan, Guatemala, January 25, 1905. Length of body, 6 inches, tail damaged.

No. 32. Collected at Gaulan, Guatemala, January 16, 1905. Length of body, 6¾ inches, tail damaged.

No. 31. Collected at Gaulan, Guatemala, January 16, 1905. Length of body, 6¼ inches, tail broken.

No. 40. Collected at Gualan, Guatemala, January 25, 1905. Total length, 24¼ inches; length of body, 6¼ inches; of tail, 18 in.

No. 24. Collected at Gualan, Guatemala, January 25, 1905. Length, 13 inches: body, 3¼ inches; tail 9¾, young ♂.

No. 54. Collected at Gualan, Guatemala, January 13, 1905. Length, 11¼ inches: body, 2¾ inches; tail 8½ inches. Young ♂, color good, crests well developed, teeth normal.

No. 35. Collected at Los Amates, Guatemala, Feb. 25, 1905. Length of body, 2½ inches, tail broken off. This is the only specimen in the collection from this locality.

No. 47. Collected at Gualan, Guatemala, January 25, 1905. Length of body, 2¾ inches, tail damaged. Crests are but slightly developed, the free dermal border of the toes is quite distinct, the teeth well developed.

No. 39. Collected at Gualan, Guatemala, January 25, 1905. Length of body, 4¼ inches, tail broken off. The crests of this specimen are fairly well developed; the markings are plainer than in the adult specimens, especially the cross bands. It is an interesting transitional stage.

No. 59. Collected at Gualan, Guatemala, January 13, 1905. Length, 17½ inches: body, 5 inches; tail, 12½ inches. This specimen has the coloration of the adult ♂, crests and teeth well developed, coloration bright.

No. 58. Collected at Gualan, Guatemala, January 13, 1905. Length, 18¾ inches: body, 4½ inches; tail, 14¼ inches; young ♂.

No. 27. Collected at Gualan, Guatemala, January 25, 1905. Length, 14 inches: body, 3¾ inches; tail, 10¼ inches. Young ♂. The crests are not prominent, teeth well developed.

LAEMANCTUS.

Laemanctus deborrii (specimen No. 28). Collected at Los Amates, Guatemala, February 25, 1905. Length 13⅞ inches: body, 3⅜ inches; tail, 10½ inches. This specimen is rather dully colored for this species, having scarcely any markings.

GERRHONOTUS.

Gerrhonotus fimbriatus, (specimens No. 9 and 16). There were two specimens of this species in the collection. Specimen No. 9 collected at Los Amates, Guatemala, February 25, 1905. Length of body is 1⅜ inches, tail broken. Specimen No. 16 was collected at Gualan, Guatemala, January 25, 1905. Length, 3¾ inches; body, 1⅝ inches; tail, 2⅛ inches.

CNEMIDOPHORUS.

This genus is represented in the collection by twenty-one specimens, presenting two species.

(*a*) Cnemidophorus espentii. There are eight specimens of this species in the collection, two adults (No. 43 and 41), and six young in various stages. The adults have very indistinct markings, spots being more prominent than the longitudinal lines of which there is scarcely a trace. In the young this condition is reversed; the spots being indistinct, or absent in very young specimens, and the lines very distinct.

No. 41 is 11½ inches in length; No. 43 is 10 inches long; the young vary 4 inches to 7⅛ inches in length, and appear relatively slimer than the adults. The tail is relatively longer in the

young specimens. C. espentii, according to Cope, is "confined to certain islands of the eastern coast of Central America," but this collection would make it appear that the species occurs commonly on the mainland. The specimens were collected as follows:

No. 43. Gualan, Guatemala, January 25, 1905.
No. 41. Gualan, Guatemala, January 25, 1905.
No. 49. Los Amates, Guatemala, February 25, 1905.
No. 46. Gualan, Guatemala, January 25, 1905.
No. 19. Gualan, Guatemala, January 25, 1905.
No 14. Gualan, Guatemala, January 25, 1905.
No. 25. Gualan, Guatemala, January 25, 1905.
No. 57. Gualan, Guatemala, January 13, 1905.

(*b*) Cnemidophorus deppii is represented in this collection by 13 specimens, 9 adults and 4 young. This species is restricted to Central America, and is closely allied to C. guttatus. In some of these specimens the anal scales are not entirely continuous with the abdominal scales as described by Cope, in four specimens there are some small scales between the larger abdominals and anals. Seven specimens have three pre-anal plates and six specimens have only two per-anals. The length varies from 3¾ inches to 9¼ inches; the average length of the adults is 7¾ inches, all above that length are males.

No. 13. Gualan, Guatemala, January 25, 1905.
No. 38 Gualan, Guatemala, January 25, 1905.
No. 22. Gualan, Guatemala, January 25, 1905.
No 17 Gualan, Guatemala, January 25, 1905.
No 15. Gualan, Guatemala, January 20, 1905.
No. 45 Los Amates, Guatemala, February 25, 1905.
No. 18. Gualan, Guatemala, January 16, 1905.
No. 56. Gualan, Guatemala, January 13, 1905.
No. 44. Gualan, Guatemala, January 25, 1905.
No 21. Gualan, Guatemala, January 25, 1905.
No 23. Los Amates, Guatemala, February 25, 1905.
No. 20. Gualan, Guatemala, January 25, 1905.
No. 8. Gaulan, Guatemala, January 16, 1905.

OPHIDIA, SNAKES.

DROMICUS.

This genus is represented in the collection by two specimens, each belonging to different species.

(*a*) Dromicus annulatus, collected at Los Amates, Guatemala, February 25, 1905. Length, 29½ inches; tail 11½ inches. Ventral scutes 153, anal bifid; sub-candal scutes 108 pair. This snake has an irridescent tinge along the sides, like some spieces of Lampropeltes.

(*b*) Dromicus omiltemanus collected at Gualan, Guatemala, January 22, 1905. Length, 14½ inches; tail 5⅛ inches. Ventral scutes 128, sub-caudal scutes, 81 pair. Scales on this specimen are in 17 rows, instead of in 19, as given in the Biologia Amer. Cen. by Gunther. Mr. H. H. Smith collected this species in Mexico at an altitude of 8,000 feet.

SPILOTES.

Spilotes salvini, collected at Gualan, Guatemala, January 22, 1905. Length 88¼ inches, tail 24½ inches; which is unusually large for this snake. Gunther gives 77 inches as the maximum. Gastrosteges 206, urosteges 129 pairs, and entire. In coloration it has much more black than the description or figure of this species in the Biol. Amer. Central, and a correspondingly less amount of yellow. The head plates are regular and correspond to the description very closely.

DRYMOBIUS.

Drymobius caeruleus, was collected at Gualan, Guatemala, January 25, 1905. Length, 39½ inches, tail 14½ inches. Ventral scutes 153, sub-caudals, 116 pair. Nine upper labials, 4th, 5th and 6th in the orbit.

DIPSAS.

Dipsas splendida, represented by two specimens (No. 33, and No. 12). The small caliber of the neck of this species in comparison with the size of the head and body make these specimens the most striking ones in the collection.

No. 12 was collected at Los Amates, Guatemala, February 12, 1905. Length, 28¼ inches, tail 8¼ inches, abdominal scutes 240, sub-caudal scutes 142 pairs, one ante-orbital; had 37 dark spots on the body, and 24 on the tail. Stomach contained the remains of three small lizards.

No. 33 was collected at Los Amates, Guatemala, February 23, 1905. Length, 33½ inches, tail, 10½ inches; sub-caudal scutes 147 pair, ventral scutes 231 pair; two ante-orbitals; the vertebral scales are longer than broad anteriorly, but broader than long posteriorly in both specimens; adult ♂; neck very slender. This snake contained six unincubated eggs, with a very light covering membrane, the species being in all probability ovoviviparous. The stomach contained the remains of three lizards and two beetles.

BOTHROPS.

Bothrops atrox; this sepcies is represented by two specimens, the only poisonous snakes in the collection; one in adult, which looks able to uphold the reputation of its insular relative, the Fer-de-lance; the other a young specimen.

No. 10 was collected at Los Amates, Guatemala, February 15, 1905. Length, 71 inches, tail 9½ inches; gastrosteges 215, urosteges 65 pairs, anal plate entire.

No. 11 was collected at Los Amates, Guatemala, February 11, 1905. Length, 21¼ inches, tail 3¼ inches; gastrosteges 197, urosteges 62 pairs. The tip of the tail of this specimen has the same bright green coloration that is seen in the young of the Copperhead (Ancistrodon contortrix) of North America. This specimen has also the horny point on the tail that is found in the adult.

West View, Pa

WATERGLASS FOR MARKING SLIDES.

ROBERT F. GRIGGS

As long as serial sections have been studied some method of marking the slides while in process of staining has been necessary. Very many devices have been proposed all of which have, so far as the writer knows, decided disadvantages. Most of them are either too cumbersome or the marks come off too easily. The following method which seems to meet all objections has not so far as I have found been previously suggested.

The medium is simply waterglass, an aqueus solution of sodium- or potassium-silicate, thinned if necessary till it will flow well from a pen The most convenient time for marking the slides is when they are first taken from the box, before they are cleaned. An ordinary steel pen of the stub or ball-pointed sort is used After the slides are marked they must be heated, either before or after they dry, preferably by holding them for a few seconds in the blue cone of a bunsen flame till the waterglass decomposes giving off strong jets of sodium light, and at the same time effervescing so as to leave behind a rough sandy surface. This is then rubbed down by a single stroke aaginst the edge of the table or any hard object and leaves a ground glass surface which, if the fixing has been properly done, is absolutely permanent and will not be affected by any reagent which does not attack the slide itself.

If desired some such dye as carmine may be stirred into the solution to make the marks more conspicuous. A whole series of colored inks could probably be made with a little experimentation but care must be exercised in choosing colors which are chemically inert because of the ease with which the silicate is precipitated.

This process takes no more time than sticking a paper label to a slide and writing the data upon it in the usual way. For serial slides where large numbers are made of the same material,

the number is frequently all the designation that is needed so that the paper label may be dispensed with. One may if he cares to, mark all the slides he makes with serial numbers and his initials keeping track of them and providing a ready means of referring to any slide irrespective of the paper label.

HIBERNACULA OF UTRICULARIA.—Last fall (late Oct. or Nov.) I brought home several winter buds of Utricularia sp. and put them into my aquarium. They were floating on the water all winter, repeatedly in ice, unchanged. With the first warm days and sun in March, they grew out rapidly and in a few days had developed branches several inches long, with numerous "utricles." V. STERKI.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, March 4, 1907.

The meeting was called to order by the President. After the reading of the minutes Mr. Ball read a paper on "The Control of the Codling Moth." He mentioned the difference of conditions between the East and the West, stating that the climate of Utah was such as to make the use of fungicides unnecessary. In his experiments he found that by using a driven spray, and spraying at the proper time, two sprayings were sufficient.

Mr. Hambleton suggested that the members of the club do more systematic work on the birds of the state.

The club then adjourned to meet the first Monday in April.

I. N. FRANK, Sec'y.

ERRATA—In April number, page 128, last line, read April instead of March

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TABLE OF CONTENTS.

SYNOPSIS OF THE AMERICAN SPECIES OF THE GENUS PAPIRIUS.

ALMA DRAYER JACKSON.

INTRODUCTION.

Every student of Entomology in pursuing his favorite subject is bound to find certain difficulties to be overcome. Some insects have very fragile bodies, while others have minute hairs and spines which are of value for classification, and must therefore be protected. Still other insects may be very hard to locate or capture without injury.

Nearly all of the above difficulties must be overcome by a student of the Thysanura. This is especially true of very minute fragile forms, as the *Aphoruridae*. While the number of specimens of Collembola collected in one day may be considerable, yet the greater majority will be found to belong to one or two species of the genus *Tomocerus*, which are very common everywhere. To secure the more rare forms requires long and careful searching, especially the genera which have such admirable color protection as we find in the genus *Papirius*.

This genus contains one or two rather widely distributed species which are quite common in places, but the remainder of the species described for America are extremely rare or limited in their range, at least we find but a small amount of literature on the species of this genus. One explanation of this is in the fact that many of the original descriptions are so brief that it would be almost impossible to identify specimens from them, even if the literature were accessible, which is frequently not the case.

It is to partially obviate this last difficulty that the present paper has been compiled, giving a brief synopsis of all known

work on our American *Papirius*. While the genus is of very little economical importance, yet it holds a unique position with respect to the other Thysanura, and to the insects in general.

It is the intention to use this paper as a foundation for future work along systematic and phylogenetic lines.

Characters of the Genus.

The characters which separate our apterous, or primitive wingless insects, into the principal groups or sub-groups are, as a rule, fairly well defined. The first attempt at classifying our apterous fauna was made by Linnaeus in 1746, when he placed all the springtails (*Collembola*) in the genus *Podura*.

In 1796 these were combined by Latreille with the genus *Lepisma* and elevated to the rank of an order under the name Thysanura. He distinguished two genera of the *Lepismidae* and two of *Poduridae*, separating out the globular shaped species under the name *Smynthurus*. This term is now used to distinguish the family whose characteristics may be defined as follows: Body globular, slightly longer than broad; the saltatorial organ present, attached to the penultimate abdominal segment; and provided with a ventral sucker.

This family, *Smynthuridae*, varies considerably from all the other groups of apterous insects in having a round, almost globular body. The antennae are very much knobbed, and consist of four segments, with the exception of the genus described by Bourlet, which he termed *Dicyrtoma*, having eight jointed antennae. However, some doubt the validity of this genus since the characters are very doubtful as the knobbed, four jointed antennae of *Papirius* might easily be mistaken for an eight-jointed one, nevertheless this genus will here be retained.

The family, *Smynthuridae*, is divided into three genera which are very closely allied and separated entirely on antennal characters as follows:

A. Terminal segment of antennae short, with whorls of haris — *Papirius*.

AA. Terminal segment of antennae long, annulated.

B. Antennae with eight segments, abdomen with two tubercles. — *Dicyrtoma*.

ΓB. Antennae with four segments, abdomen without tubercles. — *Smynthurus*.

The genus *Papirius* is distinguished by only one character, that of having a short terminal segment to the antennae with whorls of hairs, and being considerably annulated. The genus was proposed by Lubbock in 1872, having *Podura fusca* Geoffrey, as its type, and characterized by Lubbock as follows: "Body globular, antennae four-jointed, terminal segment short with whorls of hairs. Saltatory appendage comopsed of a basal portion and two arms."

However, MacGillvray in The Canadian Entomologist, Vol. XXV, gives some further characters which are of value in separating *Smynthurus* from *Papirius*. His characterization is as follows:

A. Terminal segment of antennae long, ringed; larger claw unindentate, apical segment of spring simple. *Smynthurus.*

B Terminal segment of antennae short; with whorls of hairs; larger claw bidentate; apical segment of spring serrate on the under side. *Papirius.*

Of the general characters of the family, *Papirius* possesses most of them. The antennae are long and slender, and often distinctly annulated; however these annulations have been the source of not a little confusion of the genus with *Smynthurus;* many investigators failing to see the division between the third and fourth segment. Still by careful examination there may always be found a distinct line separating the two joints.

The legs are generally long, the larger claw bearing two or more teeth. The spring is very long, and well adapted for leaping; the dentes and mucrones in most cases being serrated.

The ventral sucker is highly developed, and on agitating the insect it may be seen to throw out the long tactile filaments from the sucker.

The segments of the globular abdomen are fused; only the terminal segment being distinct. Dorsal tubercles are present in some species and also tenant hairs. The eyes are distinctly black, with prominent ocelli. The head in all species is loosely joined to the body.

The one characteristic of *Papirius* which distinguishes it from *Smynthurus* and *Dicyrtoma* is the four-jointed antennae, with the short terminal segment. *Smynthurus* has a four-jointed antennae, but the fourth segment is long, while *Dicyrtoma* has an eight jointed antennae. This character of the short terminal segment in *Papirius* is marked enough to make it quite a distinct genus.

General Anatomy.

The general plan of structure of this genus does not differ materially from that of other insects, and with the exception of the terminal joint of the antennae does not differ at all from the type of the family.

The Body, as in all *Smynthuridae*, is globular in shape, and the abdomen consists of six segments, the average length of the entire animal being about 1 mm. The shape of the body may vary to oval as in *novoeboracensis*, or sub-triangular as in *texensis*, while *unicolor* has a slightly reentering angle at the terminal segment.

The Head, is about as long as broad, and joined loosely to the body. On its upper surface are the black eyespots. These

differ considerably from the general type of insects' eyes in consisting of a smooth elevated area with very sharp, definite outline; this area being termed the eye spot. Arranged in two or more distinct rows on each eyespot are the true eyes or ocelli. These are entirely separate and function as do the simple ocelli in the higher insects. Eight ocelli are found in each eye spot, varying in size in the same species.

THE ANTENNAE. Immediately in front of the eyes are the long, slender antennae, the terminal segment of which is but little longer than the basal segment, and conical in shape. Both the third and fourth joints bearing whorls of hairs and one or both are often annulated, as in *marmoratus*, while the third joint is composed of sixteen sub-joints; in *unicolor* the third joint has seven or eight sub-joints, and the terminal segment about ten; and in *olympius* the terminal joint has seven sub-joints. As to the other sepcies we can not say, the descriptions being too brief.

THE MOUTH PARTS, are more or less withdrawn within the head and are intermediate between the true mandibular insects, and those with mouth parts adapted for sucking. The upper and lower lip appear as small, flattened, almost scale-like structures, while only the tip of the maxillae and mandibles are visible. These organs are much elongated and together with the hypopharynx may be used to rasp off particles of decayed vegetation upon which the animal feeds.

THE THORAX, as in all insects, consists of three segments, pro, meso, and meta thorax, each bearing a pair of legs. In this genus the segments of the thorax, especially the first one is greatly reduced and partially covered by the protrusion of the second segment of the thorax. As a usual thing the legs are long, slender, and covered with hairs or spines. Two claws are always present, a larger and a smaller one; the concave edges facing one another. and the larger one curved around the end of the smaller one. Small teeth may be found in various numbers on these claws; the larger claw in *texensis* and *marmoratus* bearing three teeth, while in the remainder of the species it has two, except in *novoeboracensis* of which we have no knowledge. The smaller claw is found either dilated, as in *texensis*, bearing one tooth as in *maculosus* and *unicolor*, or hairy as in *olympius* and *purpurescens*. Tenant hairs are mentioned only for *purpurescens*.

THE ABDOMEN, as before stated, consists of six segments, which with the exception of the terminal one are fused, and from the dorsal side can not be distinguished. On this account the abdomen presents a smooth even surface, sparsely covered with hairs, and never bearing scales, as is common with so many *Thysanura*. Packard's *marmoratus* is mentioned as having two pale, smooth tubercles on each side of the basal, abdominal segment and MacGillvray's *purpurescens* an anal tubercle; however,

there are none mentioned for any of the other species. On next to the last abdominal segment is an organ peculiar to the *Collembola*. This is known as the spring or furcula. It consists of four parts, as follows: attached to the abdomen is a broad, almost triangular piece, we may term the basal plate. This is covered with hairs, and forms the basal part of the spring. Attached to the anterior border of this basal plate are a couple of broad flattened pieces known as the manubrium. In some genera these are fused, but we find them separate in *Papirius* Joined to the anterior end of the manubrium are the dentes. These are long and pointed and very characteristic, usually having an inner serrated edge, and numerous characteristic hairs or spines. At the end of the dentes we find a tooth-like structure known as the mucrones. These are also serrated and very characteristic. This entire organ is nearly as long as the body. On the second or third abdominal segment is an organ known as the catch or tenaculum. This consists of a basal portion and two short arms. The entire organ is small and difficult to see and may possibly hold the spring in position. On the first abdominal segment is an organ known as the ventral sucker. This is a short tube attached at one end and free at the other. From the free end may be protruded two long filaments, nearly as long as the body. These are covered with a large number of glands which secrete a sticky substance. By means of these filaments the insect may hold fast to smooth objects, or right itself, if placed on its back.

HABITAT.

These interesting little insects may be found in numerous dark, shady nooks; under decayed wood and leaves in the woods; and always where there is some moisture, though not an excess of water. They remain quiet until disturbed, or exposed to a strong light when they prove themselves most agile in their movements. My experience has been to find them more on the under surface of chunks of decayed wood lying about in moist and damp situations than under bark. I have also taken them in numbers under stones along river banks, though never on the water where some of the *Smynthurus* are found. A most favorable time to collect *Papirius* seems to be on a warm day, just after a little very cold weather. They seem not to have thoroughly warmed up yet, and may be captured in vials quite easily by placing the vial near them and urging them on slightly by means of a small brush. They may be successfully bred in the laboratory in vials by giving them plenty of moist decayed wood and leaves to live on. These vials should be kept in the dark, giving the insects so nearly as possible their natural condition. I have tried this experiment in the case of *unicolor* and

find it most practical. As it grows colder in the fall the insects decrease in numbers. However, I have taken *P. unicolor* as late as December 13th in a comparatively open area, and after considerable cold weather and two or three snows. I do not doubt that they could be taken throughout the winter in the more protected places.

These insects are quite gregarious in their habits, and usually associate in colonies of from four or five to a dozen or more. They are very well protected by their color, which is usually of a reddish tinge in correspondence to the brown decaying wood on which they are usually found.

LIFE HISTORY.

So far as is known the eggs of *Papirius* have never as yet been observed, with the exception of *P. pini* Folsom. In connection with this I would note an experience in an attempt to solve the problem. Late in the fall some large forms of *Papirius* were placed in a vial containing damp decaying wood, and watched very closely. In about two weeks two colonies of young ones were observed, but in the meantime there had been no trace of any eggs. which might easily lead one to believe the eggs are very minute in some species.

In appearance these young are lighter in color than the adults having more of a blue tinge than the brownish-purple adults. All their organs were perfectly formed, the antennae, however, being somewhat longer in proportion to the body than in the adult. Apparently these young are quite as active as their parents in their movements. With each successive moult they grow darker and take on more the color of the adult.

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species of Papirius: *Smynthurus guttatus* Say, Pg. 25; *S. novoeboracensis* Fitch, Pg. 25; *Papirius marmoratus* Packard, Pa. 42; *P. texensis* Packard, Pg. 42.

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1903. Guthrie, Joseph E.—The Collembola of Minnesota. A descriptive catalogue of the species of the state, including: *Papirius maculosus* Schött, Pg. 58; *P. unicolor* Harvey, Pg. 59;

1896. Folsom, J. W.—"New Species of Papiruis," in Psyche Vol. 7. In this paper Folsom describes three new species of Papirius all taken at Arlington, Mass., in 1895. *Papirius hagenii* Folsom, Pg. 344; *P. pini* Folsom, Pg. 344; *P. testudineatus* Folsom, Pg. 345.

1896. Folsom, J. W.—"Notes on the Types of P. texensis Pack. and Description of a new Smynthurus." In Psyche, Vol. 7. Redescribes Packard's species: *Papirius texensis* Packard, Pg 384.

1896. Folsom, J. W.—"Two New Species of Papirius," in Canadian Entomologist, Vol. 28, May. The paper describes two new species of Papirius taken in a greenhouse at Cambridge, Mass.: *Papirius vittatus* Folsom, Pg. 119; *P. opalinus* Folsom, Pg. 120.

CHARACTERIZATION OF SPECIES.

The characters given for many of these species are so brief that it would be useless to try to form a key. Therefore we will give in summary what, from the descriptions, seems to be the chief characteristics.

1. **Papirius guttatus** (Say).

1821. *Smynthurus guttatus* Say.
1859. *Smynthurus guttatus* LeConte.
1873. *Papirius guttatus* Packard.
1895. *Papirius guttatus* Dalla Torre.

Prevailing color, yellowish-white. Head maculated. Antennae, reddish-brown, hairy. Eyes black. Body, yellowish-white with numerous irregular spots disposed in bands; numerous sparse, white hairs; two tubercles each side of the middle of the body which are truncated at the tip; ventral part of body white. Spring, flesh colored. Length, 1.3 mm. Habits, "found under the bark of the long-leaved pine (P. palustris) in Georgia."

The chief characteristics of this species as given by Say, seem to be a prevailing color of yellowish-white with numerous, irregular, reddish-brown spots. Neither MacGillvray nor Harvey have reported this species, and thus far we have only the original description. Perhaps this may be accounted for by the fact that it is a southern form, and probably with a restricted habit, since Say only mentions having found it under the bark of the long-leaved pine. The description is so very brief it would be hard to identify a specimen by it. *P. guttatus* is placed in this genus on account of the tubercles which are not found in the genus Smynthurus.

2. **Papirius novoeboracensis** (Fitch.)

1862. *Smynthurus novoeboracensis* Fitch.
1873. *Papirius novoeboracensis* Packard.
1893. *Papirius novoeboreacensis* Harvey.
1895. *Papirius novoeboracensis* DallaTorre.

Prevailing color, dull brownish-yellow. Head pale. Antennae nearly the length of the body, long and slender. Eyes black. Body but little broader than head, oval, slightly attenuated at its tip, with an impressed, transverse line conspicuously separating the apex from the body. Legs light yellowish-brown in color. Length about 2 mm. Habits under rubbish and boards.

The chief characters, as given by Fitch, which distinguishes this species, as a *Papirius* is. as he says, "the length beyond the elbow of the antennae being obscurely divided into three joints." This point was definitely settled by Harvey who examined the type specimens and said that Fitch in his work had overlooked

the short end joint which would classify it as a *Papirius.* This species is quite akin to *unicolor* with which it almost agrees in size and habit, differing in color and form of antennae.

3. **Papirius marmoratus** Packard.

1873. *Papirius marmoratus* Packard.
1893 *Papirius marmoratus* Harvey.
1895. *Papirius marmoratus* DallaTorre.

Prevailing color deep, dull lilac, with pearly colored lines and spots. Head large, free from body, swollen on the sides and over the clypeal region. Antennae dull lilac, paler on basal half, terminal half of third joint divided into sixteen sub-joints, much swollen, fourth joint rather long, annulated. Eyes black. Body marbled over with deep, dull lilac, and pearly colored lines and spots, a median dorsal, pearly streak along the basal half of the abdomen, beneath light, pearly, marbled with lilac; elongate oval in form with two pale, smooth tubercles on each side of the middle of the first abdominal segment, the two following segments narrow, and projecting far out like a fungoid growth. Legs dull lake, femur pearly at base and end; tibia alternate light and dark lilac; claws, superior one with four teeth, obscure. Furcula pale lilac, in the young whitish: dentes serrulate beneath; mucrones long and slender, oval at tip. Length 2.5 mm. Habits, "on toad stools, abundant at Brunswick, Maine, Sept. 10, and Woods Hole, Mass., Sept. 15, (Packard); vicinity of Boston (Sanborn)"

"This fine marbled species may be known by its decided lilac hue, and meidan pale line, as well as the two pale dorsal tubercles and its large size." (Packard). Fifteen type specimens deposited in the museum of Comparative Zoology.

4. **Papirius texensis** Packard.

1873 *Papirius texensis* Packard.
1895 *Papirius texensis* DallaTorre.
1896 *Papirius texensis* Folsom.

Prevailing color pale luteous, marbled with brown and black. Head paler, a few short bristles above the mouth and on the posterior dorsum; long stout hairs on the vertex and anterior dorsum. Antennae shorter than body, pale reddish-brown, growing darker toward the end; segments nearly as 1:5:5:2; basal segment twice as long as broad, naked; second sub-petiolate, sparsely hairy; third petiolate, hairy with ten distinct sub-segments, the penultimate one laterally-dilated, fourth segment lanceolate. Eyes black. Legs long, slender, tibia with broad, alternate light and dark bands. Claws; superior one, long and slender, little curved, obscurely toothed; inner edge sinuate basally, toothed in the middle and obscurely beyond. Two teeth on either side

near the outer edge dividing it into thirds; inferior claw two-thirds as long as superior, stout and tapering, with a short bristle inside upon a rounded basal dilation, and with a sub-apical bristle exceeding the other claw in length; tenant hairs absent. Furcula nearly reaching the mouth, manubrium with a few ventral hairs; dentes tapering with remarkably long and large lateral hairs, barbellate basally, and four long equidistant ventral hairs; mucrones one-fourth length of dentes, laterally linear, little tapering, serrulate beneath, apex with three rounded lobes bent downward. Length 1.3 mm. (Folsom-Packard). Habitat, "Waco, Texas."

"Very closely allied to *P. marmoratus*, but is more hairy, the body more finely marbled appearing as if tuberculated, while the skin of *P. marmoratus* is smooth; it also wants the two, pale, smooth tubercles on the body of the latter." (Packard.) The type specimens were redescribed by Folsom who stated that 'The tube containing them was found to hold not only fourteen specimens of a *Papirius*, but also ten examples of a *Smynthurus*, and the original description of *P. texensis* evidently combines the characters of both these species which certainly do resemble each other superficially." Type specimens in the museum of Comparative Zoology.

5. **Papirius maculosus** Schött.

1891. *Papirius maculosus* Schött.
1895. *Papirius maculosus* DallaTorre.
1903. *Papirius maculosus* Guthrie.

Prevailing color, a whitish-ground color sometimes varying to a yellowish or grayish tone, almost the entire upper part of the body showing dark, blue spots of various forms which often vary to a sky blue; clear white on ventral side. Antennae dark blue; shorter than body. Legs with distal half of tibia white. Claws; superior claw armed with two teeth, inferior claw with a single perpendicular tooth. Furcula pale violet; manubrium short; dentes about three times as long as mucrones, bearing two distinct kinds of hairs, simple, and pinnate or notched, regularly arranged, two pairs of notched hairs being between two simple hairs, the most distal of the simple hairs reach almost to the mucrones. Length, 1.5 mm.

This species seems to have a rather wide range. Guthrie reports it abundant in Minnesota, and the original description was taken from specimens collected in California. The species seems very closely allied to *P. marmoratus*, and according to Guthrie, may be a variety of this species. The color seems to be somewhat lighter, with slight variations in markings.

6. **Papirius unicolor** Harvey. Plates XI and XII.

1893. *Papirius unicolor* Harvey.
1895. *Papirius unicolor* DallaTorre.
1903. *Papirius unicolor* Guthrie.

Prevailing color light brownish-purple throughout, color much like that of a Delaware grape; back, end of legs, and apical half of the antennae darker; dorsum often with two interrupted stripes of darker shading, head, base of antennae, base of legs, spring and ventral surface lighter; young, half grown specimens, and full grown specimens in damp situations paler; occasionally a very large specimen and those taken in dry places are more brown, but all show the purple tint. Sides of full grown specimens often obscruely marked with pale oblong spots. Head viewed from front as long as broad, depth half the length; elevated between the eyes and bearing a tuft of long hairs. Antennae long, slender, elbowed at the second joint, nearly as long as the body; basal joint short but slightly longer than the terminal one; second joint shorter than third, the portion beyond the elbow usually somewhat longer than the two basal joints; third joint usually the longest, the terminal half composed of seven or eight sub-segments; terminal joint, short, conical, narrower than the club-shaped end of the third joint; composed of about ten sub-segments, the three basal of which are about the same length, and obscure, fourth and fifth wider and well defined, sixth and seventh narrower and somewhat obscure; each segment bears a whorl of hairs, and as there are three whorls on the portion below the seventh segment probably it represents three more joints; when walking the basal joint of the antennae is projected upward and outward from the head; the apical portion beyond the elbow outward and downward. Eye patches prominent, elevated, black, bearing eight ocelli, four in the inner row, three in the outer with a single small one in the midlde; the second ocellus from the front in the inner row is also smaller than the others. Body, including head, twice as long as broad, breadth and depth equal, gradually widening from the neck to the greatest width, abruptly narrowing with a slight re-entering angle to the conspicuous terminal segment. Legs long. Claws prominent; larger curved and bearing two teeth on its inner face, below the middle; smaller claw slender, over half the length of the other with a small tooth on its inner surface. Furcula rather long and slender from about three-fourths to longer than body; mucrones less than half the length of dentes, lanceolate, unarmed, concave below and bearing on each edge of the concavity a row of about forty teeth, which increase in size outward and at the end join in a common tubercle; dentes long, slender, covered with hairs. Ventral sucker short, cylindrical, tactile filaments white, covered with papillae, nearly as long as body.

Length 1.9 mm.; head .8 mm. long, .8 mm. broad, .4 mm. deep from front to back; antennae 1.7 mm. long, joints in the ratio of 7:22:25:6; body 1.6 mm. long, .8 mm. broad, .9 mm. deep; spring 1.6 long, segments in the ratio of 5:6:2; sucker, including filaments, 1.5 mm. long. Habits, found in numerous localities, under decaying wood, under damp stones, or boards, and occasionally found on various species of fungus.

This is one of the most common and widely distributed species of the genus. I have found it quite abundantly in Ohio, and it has been reported as abundant in Maine by Harvey who found it associated with *P. marmoratus* on Agarics and Boleti, and has also been reported from Minnesota by Guthrie. I have taken it in mid-winter in Ohio, where it occurs in small colonies in suitable localities. The very young have a decidedly bluish tint, but otherwise resemble the adults very closely. They are sluggish in their movements, but when disturbed can jump eight or ten inches. Harvey states that the smaller claw is over a halt the length of the larger; however, in all the specimens I have examined a long-hair-like projection extends beyond the end of the larger claw.

7. **Papirius olympius** MacGillvray.

1893. *Papirius olympius* MacGillvray.
1895. *Papirius olympius* DallaTorre

Prevailing color reddish, spotted with dark brown, in young specimens purplish. Head, vertex covered with stiff bristles; a longitudional brown band extending from the back of the head to the eye spot, another in the middle of the vertex extending down the middle of the front. Antennae nearly as long as the body, purplish, hairy, basal segment light at base, dark at apex and one-fourth the length of the second; second segment one-half the length of the third, third segment slender, with seven sub-segments at apex; fourth segment with six sub-segments. Eye spot black. Abdomen and thorax with two sinuate brown bands on each side of the dorsum, the middle ones meeting at the apex and base of the thorax and on the basal half of the abdomen; also a band extending from this basal transverse band of the abdomen along the middle of the back towards the head bilobed in front, a triangular spot just before the apex of the abdomen, and promiscuous brown mottlings on the side; body covered with broad flattened hairs. Legs reddish, long, slender, spiny. Claws long, outer three times as long as the tibia is broad, with two teeth; inner two-thirds the length of outer, with a hair at apex reaching beyond the apex of the outer claw; tenant hair wanting. Furcula long, slender; manubrium short, two-thirds the length of dentes; dentes with a row of long, hair-like spines along the side of each member; mucrones about one-fourth the length of dentes, serrate beneath.

Length 2–3 mm. "Habitat, Olympia, Washington."

Apparently MacGillvray is the sole collector of this species in America so far, at least we have no record given of it by any one else.

8. **Papirius purpurescens** MacGillvray.

1893. *Papirius purpurescens* MacGillvray.
1895. *Papirius purpurescens* DallaTorre.

Prevailing color, blackish purple. Head between the antennae washed with yellow. Basal segment of the antennae very short, one-third the length of the second; second segment white or transparent. Body, dark purple; abdomen slightly hairy, the hairs more abundant at the posterior end; last segment fringed with clavate hairs. Legs long, slender, hairy. Claws short, stout; superior claw with two teeth, one at the middle, the other at the base; inferior claw nearly as long as the superior, more slender with two bristles at the tip; tenant hairs present. Furcula dark purple, long, slightly hairy above; dentes half the length the manubrium, narrowed beyond the base; mucrones one-fourth the length the dentes; apex blunt, serrated at the middle. Length 3 mm. Has been reported only from Long Island.

This is one of the largest species of *Papirius*, and has never been reported except by MacGillvray.

9. **Papirius hagenii** Folsom.

1896 *Papirius hagenii* Folsom.

Prevailing color, yellowish-orange with purple markings. Head translucent, orange ochraceous, orange around the mouth, a few stiff bristles upon the vertex and face. Antennae nearly as long as body, orange, becoming purplish on the last few segments; basal segment naked; second four times as long as the first; a few hairs distally; third equalling second plus one-half of first, verticillate; terminal segment twice as long as basal, with whorls of hairs, as is common to the genus. Eyes black. Body, thorax yellow, abdomen oval in dorsal aspect, dark purple, almost black covering the sides and pale ventral surface with a well defined but zigzag margin; a yellowish-brown pattern on posterior half of dorsum very variable in shape, usually consisting of five elongate markings which may or may not be united; posterior part of abdomen with a few short, white bristles, longer on the terminal segment. Legs yellow, paler at base; tibia spiny. Claws transparent, slender, rather straight, little curved inside; superior claw with a sharp tooth inside one-third distant from apex; second tooth obscure, in the middle; inferior claw two-thirds the length of superior, with one stout knobbed tenant hair, twice as long fixed on its inner side, except at its tip which is free. Furcula long, extending to mouth, stout, pale yellow

at base, becoming white distally; manubrium over one-third the dentes in length; dentes three times the mucrones, each dentes with a row of long spines on either side; mucrones cylindrical, apex rounded, minutely serrated beneath, ventral abdominal surface with an oval, yellow swelling either side of the manubrium, and two similar but much larger ones placed obliquely and anteriorly. Length 1.3 mm.; maximum 1.5 mm. Habits: reported by Folsom as occurring as an active, uncommon species, in pine woods, under damp decaying twigs and needles, Arlington, Mass.

10. **Papirius pini** Folsom.
1896. *Papirius pini* Folsom.

Prevailing color, chestnut-brown. Head pale, a few short stiff bristles upon a protrubence on the vertex, and down sides of the face. Antennae four-fifths the length of body; basal segment stout, naked; second four times as long with a few long hairs distally; third equalling the first two with distal half; divided into seven distinct sub-segments, and three others less evident swollen terminal ones; each sub-segment with a pair of hairs, a few hairs near the base of the third joint; fourth segment equalling basal in length, with whorls of long hairs. Eyes black. Body, abdomen ovate dorsally, dilated at sides; dorsum darker with several long, white bristles anteriorly, and very short bristles posteriorly; anal tubercle with long, stout bristles. Legs long, slender ,spiny, especially on tibia. Claws, superior one long, rather straight, a sharp tooth in the middle, and another midway between it and the tip, a third tooth on the outside nearly opposite the last; inferior claw with straight, tapering sides, and an apical hair hardly longer than the other claw; the extreme tip of the claw free from the hair. On the inside of the inferior claw, near the base is a dilation whose apex bears a short bristle. Furcula pale, extending beyond the ventral tube; manubrium stout; each dentes with a row of long spines on either side; mucrones tapering, one-third the length of dentes, coarsely serrated beneath. Length 1.6 mm. Habits, reported by Folsom as living on the under side of pine logs, and eating the wet decayed wood.

This species has been reported only by Folsom from Arlington, Mass., the description being taken from twelve specimens found during October and November. Concerning the habits the author further says, "The last specimens found before a severe frost were all females which laid numerous eggs in captivity when given natural conditions of moist food, air and darkness. The eggs, laid singly, were spherical, with strongly flattened ases, translucent white, smooth, .3 mm. in diameter, .15 mm. igh, and with embryos quite undeveloped several days after epo sition."

11. **Papirius Testudineatus** Folsom.

1896. *Papirius testudineatus* Folsom.

Prevailing color, dark purple, almost black with conspicuous wax yellow patterns. Head large, face with large markings and a few short bristles; vertex with a few long bristles, and a stirrup shaped marking in the middle; behind this a long, broken, transverse band. Antennae, .7 the length of body, purplish; basal segment twice as thick as second; second five times as long as first, somewhat petiolate with a few hairs; third equalling first two, slightly petiolate, gradually forming sub-segments distally, the first seven of which are distinct, and the three distal ones much swollen, especially the penultimate one; terminal segment equal to basal in length; third and fourth segments with whorls of long hair. Eyes black. Body, abdomen ovate dorsally, with a large pattern composed principally of thick median, longitudional and oblique bars; dorsum with a few long bristles anteriorly, many short ones posteriorly; sides with large, elongate spots; anal tubercle large, with several large spots, and many stiff bristles. Legs very long, slender, hairy, with broad, alternate bands of purple and yellow, except on the tibia. Superior claw long, of rather uniform width, bent only towards the tip, divided on the inside nearly into thirds by two prominent teeth; inferior claw half as long, conical in shape, apparently prolonged into a bristle; a short bristle on inside of inferior claw at its base. Furcula long, nearly reaching mouth, purplish; each dentes with a row of long spines on either side; mucrones white, cylindrical; apex rounded, one-third the length of dentes, serrated beneath. Length 2.2 mm.

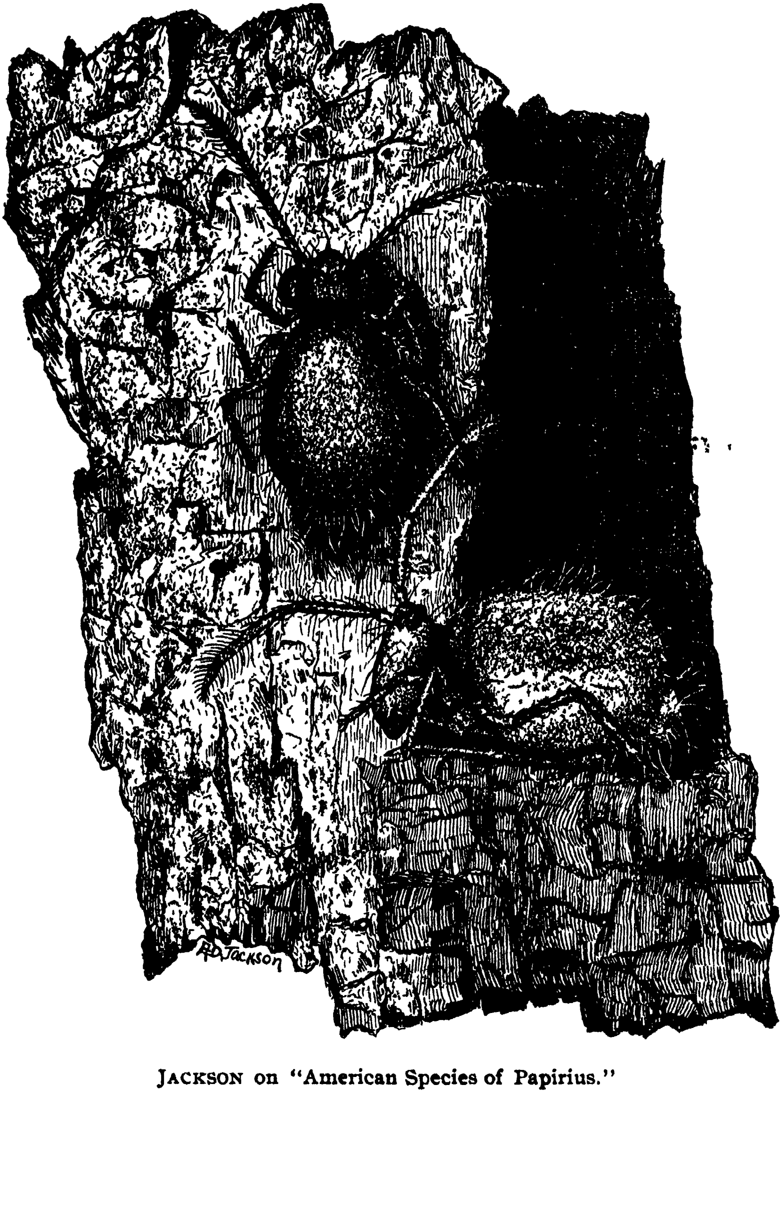
The description was taken from four specimens which were deposited by Mr. Folsom in the Cambridge Museum of Comparative Zoology.

12. **Papirius vittatus** Folsom.

1896. *Papirius vittatus* Folsom.

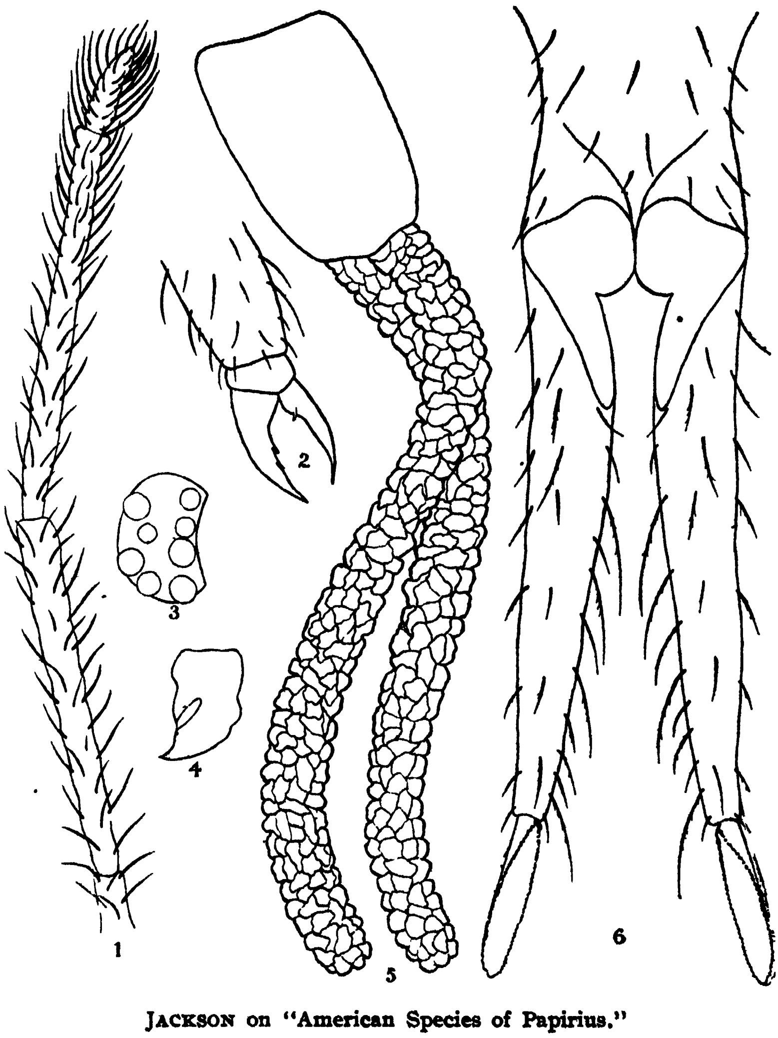
Prevailing color, young specimens dark purple above with pearly markings, lavender or lilac beneath; older ones maroon to almost black above, sides mottled with several shades of purple and brown. Head free, purple with a broad transverse band across the front, oral region whitish, vertex with a distinct white sagittal mark from antennae to pro-thorax; black ocelli-like effect on the middle of the vertex; a few short bristles upon the vertex in front. Antennae longer than the body, except in large individuals; segments variable in relative length, but approximately in the ratio of 1:6:7:1.5, or 1:7:9:2; basal segment short, as long as broad, brownish with short white bristles, the remainder of the segments sparsely haired, the third with five to seven sub-segments with whorls of hairs. Eyes dark, close behind the

OHIO NATURALIST. *Plate XI.*



JACKSON on "American Species of Papirius."

OHIO NATURALIST. *Plate XII.*



JACKSON on "American Species of Papirius."

antennae upon a black patch with a narrow border of purple. Body, ovate dorsally with a re-entering angle; dorsum dark purple to black with a pattern in pearly white essentially as follows: on anterior half of dorsum a median longitudional purplish streak between two pearly streaks with dentate margins; behind these a square purple spot bounded by pearly and bisected by a short median, longitudional, pearly streak; on either side two short irregular pearly lobes extending obliquely forward; next behind on the median line are one to three roundish purple spots broadly surrounded by pearly white; on posterior abdomen a long, oblique, pearly bar directed forward from either side of the median line; abdomen with a small pale tubercle on either side of the middle; dorsum naked anteriorly with short white bristles posteriorly; anal tubercle with bristles four times as long and with a median longitudional purple bar; sides purple to blackish, with conspicuous, hazel, chestnut and cinnamon mottlings· thorax with a broad, lateral longitudional, pearly band, sometimes replaced by one to four bright white spots; sides of abdomen with two to five large conspicuous pure, white spots, widely separated; ventral surface lilac or lavender. Legs long, purple and yellow; tibia with broad alternate bands of dark violet and wax yellow; bristles white. Claws, white, superior claw long, tapering ,rather straight, six toothed; inner edge with two prominent teeth at about equal intervals, two more on both sides near the outer edge, dividing it into thirds; inferior claw half as long as the other, straight, tapering, bearing sub-apically a slender bristle longer than the claw; also a tooth upon a swelling on the inner edge near the base. Furcula almost reaching the head, manubrium, stout, purple; dentes twice as long, slender, pale lilac; each with a long, white bristle on either side and a single extra long ventral sub-apical bristle; mucrones, white, less than one-third the dentes, narrowly elliptical; ventral concavity shallow with distinct serrate edges; apex clearly emarginate, having a median rounded, quadrate notch between two rounded teeth. Ventral sucker with filaments extensible to the length of the antennae. Length, maximum, 3.3 mm. Habits; reported by Folsom from a green house at Cambridge, Mass., upon wet decaying wood, and upon the outside of algae coated flower pots in shaded, moist situations.

This species seems to be quite abundant, and closely resembles *P. marmoratus*, but differs from this species in the character of its claws, having six teeth on its superior claw, while *marmoratus* has but four. It is easily recognized by the broad white head band with sagittal mark, the three median dorsal streaks, and the brilliant white spots on the sides of the abdomen. Types were deposited in the Museum of Comparative Zoology at Cambridge.

13. **Papiruis opalinus** Folsom.

1896. *Papirius opalinus* Folsom.

Prevailing color, orange-rufous or ferruginous. Head; first two antennal segments, anal tubercle, and legs pale orange-ochraceous. Head with a few short bristles on front, vertex almost naked, swollen dorsally. Antennae shorter than the body, from three fourths to one-half as long according to age; basal segment twice as long as broad, naked; second three or four times as long, knotty, and hairy toward the epex; third purple, four or five times the basal in length; distal end knotty, and hairy; terminal segment purple, one and a half times as long as basal, lanceolate with whorls of white hairs. Eye spots black, often quadrate. Body, regular, elongate, oval in dorsal outline; anterior dorsum naked, translucent orange-ochraceous with a broad and median shading of green due to chlorophyll in the stomach; posterior dorsum and sides orange-rufous to dark ferruginous often with a tinge of maroon; posterior dorsum with short, white bristles upon minute brown orange - ochraceous spots; anal tubercle hardly visible from above; ventral surface pale yellow, with three pairs of buff, yellow tubercles; a small round tubercle on either side of the manubrium; a large oval oblique one either side of the middle; a narrow oblique pair anterior to these. Legs slender; femur with short, sparse bristles; tibia pale distally, stout spines at moderate intervals. Claws white, very stout; superior claw of almost uniform width, little curved towards the apex, six toothed; inner edge with a tooth at the middle and another midway between it and the apex; two pairs of lateral teeth similarly placed near the outer edge; inferior claw two-thirds as long as the other, triangular in shape, tipped with a short bristle, inner edge sinuate or straight with a short bristle one-third from its base. Furcula short, reaching to the ventral tube; manubrium sparsely hairy; dentes twice as long, stout, pale orange-rufous with short lateral bristles and several longer ventral bristles at regular intervals; mucrones white, one-fourth the dentes in length, oblong finely serrated beneath, apex rounded. Ventral sucker pale orange-ochraceous, the tube and filaments together one-fourth as long as the antennae. Length, maximum, 1.3 mm. Habitat: reported by Folsom from a green house, Cambridge, Mass. Found in company with *P. vittatus*.

The description was taken from a large number of species, types of which were placed in the Museum of Comparative Zoology.

Explanation of Plates.

Plate XI.

Enlarged drawing of *P. unicolor*, showing the insects in their natural environment.

Plate XII.

***P. unicolor:* 1, antennae; 2, claw; 3, eye spot; 4, tenaculum; 5, ventral sucker and filaments; 6, spring.**

OHIO PLANTS WITH PUNCTATE GLANDS AND GLANDULAR SCALES AND PUBESCENCE.

EDNA M. McCLEERY.

The subject of glands is interesting from a morphological as well as from a physiological stand-point. In their morphology plant glands represent very diverse structures and in the following article an attempt has been made to classify certain types of Ohio glandular plants as a basis for future ecological and physiological studies. In this paper resin ducts as are present in the stems and leaves of Conifers will not be considered.

There are about sixty Ohio plants which have internal punctate glands such as are found typically developed in the Polygonums and Hypericums. These glands can usually be seen with the naked eye if the leaf is held up to the light, but with the aid of a small lens all are quite distinctly seen. The glands usually appear light in color, but some are black and a few yellow. The size is variable but usually the smaller the glands the more numerous they are.

Most punctate glands are internal although some leaves, as the prickly ash, have the epidermis modified into large cells which are probably used in secreting the contents of the gland. The gland of the prickly ash (Fig. 1) is made up of many layers of modified cells, each cell having a prominent nucleus. The cell and nucleus stain about the same color as the palisade tissue. In most of the cross-sections of the leaves the glands are about as deep as the palisade tissue, but in some of the older leaves, where development is complete the glands extend far down into the spongy tissue (Fig. 2). At the top of each gland of prickly ash there are a number of cells entirely different from the ordinary epidermal cells. They are larger than the epidermal cells, stain about as dark as the palisade tissue and have large dark nuclei. They are very conspicuous in a cross-section showing as a row of from three to six cells across the top of the gland, but in a tangential section they appear in a more or less circular plate of from nine to thirty-six cells.

The internal glands of the Hypericum (Fig. 5) are of much the same type, but differ in two particulars. Instead of having a many-layered gland-wall, the wall is thin, being made up of a single layer of cells. These cells stain darker than any other part of the leaf. The cell usually extends about as deep as the palisade tissue, although most of the sections of Hypericum show a double row of palisade. The second point of difference between this and the prickly ash is that the Hypericum does not have the compact plate of cells in the epidermis. The covering above the gland appears perfectly normal. Hypericum maculatum has black dots instead of the light ones. These black dots

have practically the same structure as the light glands, but are made dark by the secretion which is contained in them. The age of the leaf may also have some influence on the darkness of the spot.

The glands of Boebera papposa (Fig. 4) appear to the naked eye as large yellow spots, oval in shape. The gland wall is very thick being made up of a number of layers of cells like the prickly ash. The cells composing the wall stain quite dark on the outside, but the inner layers take the stain much less prominently. The cells in the innermost layer are irregular in shape and remain very light in color. They are sharply limited from the adjoining layer by a definite heavy wall. The gland is a little less than twice as long as broad, and extends from the upper epidermal layer to the lower epidermis.

The internal glands of this type usually secret volatile oils, but the glandular peltate scales found on the surface of the leaves and stems very commonly secret resin, although no absolute distinction can be made. Gaylussacia resinosa (Fig. 8) is provided with external scales on the under side of the leaf. These scales are attached to the leaf by stalks which are made up of about seven cells. The scale itself is divided into from six to ten cells. The resin is secreted from this and as the scale becomes mature the outer covering is pushed off by the secretion. This produces a bulging out of the scale, and the whole structure is surrounded by a mass of bright yellow resin. The illustration shown in most texts of this type is the gland found on the bracts of the common hop Humulus lupulus, but the hop gland is more simple in structure. The cross-section of the leaf of Gaylussacia shows no further adaptation for secretion, and even the lower epidermal covering is perefctly normal. The longitudinal section shown (Fig. 9) is cut through the base of the disc and therefore shows one central cell of the stalk and eight surrounding cells of the scale proper. These cells show rather large dark nuclei and contain abundant cytoplasm.

In Glecoma hederacea, common ground ivy, (Fig. 7), resin is also secreted, but the position of the scale is somewhat different. Instead of secreting scales on the surface of the epidermis, the organs for this purpose are in depressions or pits. The gland has a stalk of two cells and below a scale showing a row of from three to six cells in cross-section. These cells stain quite dark but the nuclei can be seen without difficulty. The outer wall of the scale is separated from the protoplasm of the cells by a definitely limited clear space.

Besides the glandular tissue on the inside and glandular scales, other glandular structures are developed from the epidermis which represent true epidermal hairs or emergences. The hairs may be of different types, unicellular or multicellular.

Corylus americana (Fig. 12) has glandular emergences of the multi-cellular type. The stalks show from five to ten rows of cells on one side and the glandular heads are also multi-cellular. Cypripedium reginae (Fig. 11) has multi-cellular glandular hairs consisting of three stalk cells and a head cell. The basal cell is rather large and extends below the surface of the epidermis. The top or head cell is enlarged and rounded in shape with a slight depression on the top. The four cells each show large nuclei and the head cell is filled with granular cytoplasm. Juglans has glandular hairs which have multi-cellular heads. The cells are formed by longitudinal divisions and a plate of cells is formed. The stinging hairs of Urtica dioica (Fig. 10) are glandular, but of a different type. The hair consists of an enlarged multi-cellular base and a single-celled top. This hair gives our formic acid on being broken.

The following lists represent the Ohio plants having the various types of glands considered:

Punctate Leaves.

Polygonum incarnatum Ell.
" lapathifolium L.
" pennsylvanicum L.
" persicaria L.
" careyi Olney.
" hydropiperoides Michx.
" hydropiper L.
" punctatum Ell.
" virginianum L.
" scandens L.
" sagittatum L.
" arifolium L.
Amaranthus hybridus L.
" retroflexus L.
" spinosus L.
" blitoides S. Wats.
" graecizans L.
Acnida tamariscina tuberculata (Moq.) Uline and Bray.
Magnolia acuminata L.
Liriodendron tulipifera L.
Caltha palustris L.
Psoralea pedunculata (Mill.) Vail.
Psoralea onobrychis Nutt.
Amorpha fruticosa L.
Kuhnistera purpurea (Vent.) MacM.
Xanthoxylum americanum Mill.
Ptelea trifoliata L.
Polygala cruciata L.
" verticillata L.
" ambigua Nutt.
" incarnata L.
Polygala viridescens L.
" senega L.
" polygama Walt.
" paucifolia Willd.
Ascyrum hypericoides L.
Hypericum ascyron L.
" kalmianum L.
" prolificum L.
" adpressum Bart.
" spaerocarpum Michx.
" ellipticum Hook.
" virgatum Lam.
" maculatum Walt
" perforatum L.
" subpetiolatum Bickn.
" boreale (Britt.) Bickn
" mutilum L.
" gymnanthum Engelm. and Gray.
" majus (Gr.) Britt.
" drummondii (Grev. and Hook.) T. and G.
Triadenum virginicum (L.) Raf.
Lysimachia quadrifolia L.
" terrestris (L.) B. S. P.
" nummularia L.
Naumbergia thyrsiflora (L.) Duby.
Grindelia squarrosa (Pursh) Dunal.
Euthamia graminifolia (L.) Nutt.
" caroliniana (L.) Greene.
Boebera papposa (Vent.) Rydb.

GLANDULAR SCALES.

Myrica cerifera L.
Comptonia peregrina (L.) Coult.
Betula populifolia Marsh.
" alba pendula Hortorum.
" nigra L.
" lenta L.
" lutea Mx. f.
" pumila L.
Ribes floridum L'Her.
Gaylussacia resinosa (Ait.) T. & G.
Glecoma hederacea L.
Monarda didyma L.
" clinopodium L.
" fistulosa L.
Blephilia ciliata (L.) Raf.
" hirsuta (Pursh.) Torr.
Clinopodium glabrum (Nutt.) Kuntze.
" vulgare L.
Origanum vulgare L.
Koellia flexuosa (Walt.) MacM.
" virginiana (L.) MacM.
" pilosa (Nutt.) Britt.
" incana (L.) Kuntze.
" mutica (Michx.) Britt.
Thymus serpyllum L.
Cunila origanoides (L.) Britt.
Lycopus virginicus L.
" rubellus Moench.
" americanus Muhl.
Mentha spicata L.
" piperita L.
" citrata Ehrh.
" longifolia (L.) Huds.
" arvensis L.
" sativa L.
" canadensis L.
Collinsonia canadensis L.
Eupatorium perfoliatum L.
" coelestium L.
" altissimum L.
Lacinaria squarrosa (L.) Hill.
" cylindracea (Michx.) Kuntze.
" scariosa (L.) Hill.
Grindelia squarrosa (Pursh.) Dunal.
Tetraneuris acaulis (Nutt.) Greene.
Helenium autumnale L.
" nudiflorum Nutt.
" tenuifolium Nutt.
Helianthus strumosus L.

GLANDULAR HAIRS AND EMERGENCES.

Juglans cinerea L.
Ostyra virginiana (Mill.) Willd.
Corylus americana Walt.
Urtica dioica L.
Urtica gracilis L.
Chenopodium botrys L.
" ambrosioides L.
Blitum capitatum L.
Allionia hirsuta Pursh.
Silene virginica L.
" rotundifolia Nutt.
" regia Sims.
" caroliniana Walt.
" antirrhina L.
" noctiflora L.
Polanisia graveolens Raf.
Drosera rotundifolia L.
" intermedia Hayne.
Sullivantia sullivantii (T. & G.). Britt.
Heuchera americana L.
Rubus odoratus L.
" phoenicolasius Maxim.
" nigrobaccus Bailey.
Drymocallis arguta (Pursh.) Rydb.
Agrimona hirsuta (Muhl.) Bickn.
" striata Michx.
Rosa setigera Michx.
" canina L.
" rubiginosa L.
" gallica L.
Crataegus coccinea L.
" rotundifolia (Ehrh.) Borck.
" macracantha Lodd.
" mollis (T. & G) Scheele.
Cassia nictitans L.
" chamaecrista L.
" marylandica L.
Ceanothus ovatus Desf.
Rhexia virginica L.
Phacelia bipinnatifida Michx.
Trichostema dichotomum L.
Scutellaria cordifolia Muhl.
Physalis heterophylla Nees.
Antirrhinum majus L.
Scrophularia marylandica L.
Pentstemon cobaea Nutt.
Gratiola virginiana L.
Dasystoma pedicularia (L.) Benth.

Martynia louisiana Mill.
Ruellia strepens L.
" strepens micrantha (Engelm & Gray) Britt.
" ciliosa Pursh.
Triosteum perfoliatum L.
" angustifolium L.
Gnaphalium decurrens Ives.
Anthemis cotula L.
Woodsia obtusa (Spreng.) Torr.
Dennstaedtia punctilobula (Michx.) Moore.
Phegopteris hexagonoptera (Michx.) Fee.
Tofieldia glutinosa (Michx) Pers.
Cypripedium acaule Ait.
" reginae Walt
" caudidum Willd.
" hirsutum Mill
Cypripedium parviflorum Salisb.
Peramium pubescens (Willd.) MacM.

Explanation of Plate XIII.

Fig. 1. Cross section of leaf of Xanthoxylum americanum Mill. showing position and character of a normal internal gland.

Fig. 2. Cross section of leaf of Xanthoxylum americanum showing an unusually large gland.

Fig. 3. Longitudinal section of gland of Xanthoxylum americanum.

Fig. 4. Cross section of leaf of Boebera papposa (Vent.) Rydb., showing internal gland.

Fig. 5. Cross section of leaf of Hypericum prolificum L, showing position and character of internal gland.

Fig. 6. Longitudinal section of gland of Hypericum prolificum

Fig. 7. Section of leaf of Glecoma hederacea L. showing external scale.

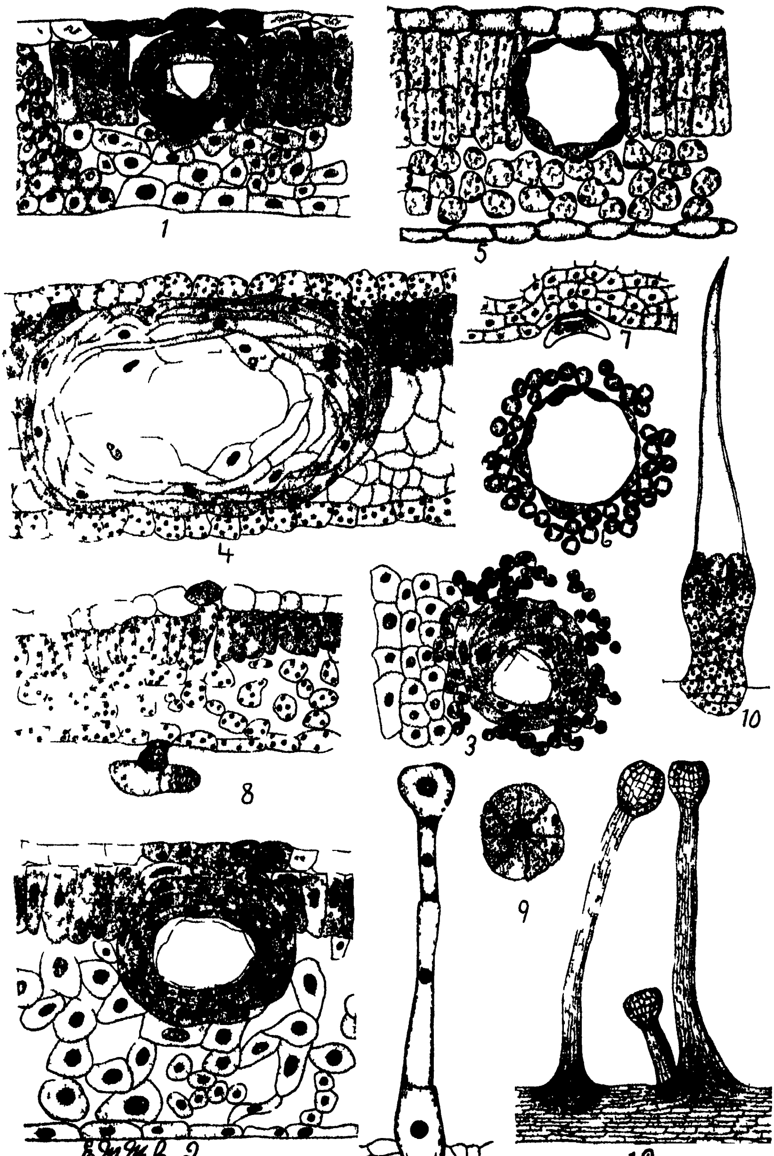
Fig. 8 Cross section of leaf of Gaylussacia resinosa (Ait) T and G., showing position and character of an external secreting scale

Fig. 9. Section of scale of Gaylussacia resinosa, showing central stalk cell.

Fig. 10. Glandular hair of Urtica dioica L.

Fig. 11. Glandular hair of Cypripedium reginae Walt.

Fig. 12. Glandular hairs of Corylus americana Walt.



McCLEERY on "Punctate Glands"

THE DEVONIAN LIMESTONES OF CENTRAL OHIO AND SOUTHERN INDIANA.

CLINTON R. STAUFFER.

A comparative study of the two regions, lying on opposite sides of the Cincinnati island, shows that there is a remarkable similarity between the Devonian limestones of central Ohio and southern Indiana. This is perhaps more evident from a lithological point of view although the paleontology of the formations of the two places is very similar and the stratigraphic arrangement is identical.

These deposits in Ohio have been divided into the Columbus and Delaware limestones. The Columbus presents two very different lithological phases which are persistent throughout the state. In southern Indiana Dr. Edward M. Kindle has recognized three distinct formations, the Geneva and Jeffersonville limestones and the Sellersburg beds,[1] the latter including the Silver Creek hydraulic limestone of some authors.

The lower of these Indiana formations, stratigraphically, is the Geneva limestone which "is generally a massive light buff to chocolate brown saccharoidal magnesian limestone" in which "fossils are extremely rare at most locations and occur usually as casts when found."[2] It thins out toward the Ohio river but may be seen in the vicinity of Charleston, along the hill above the "Lick" and at the road side east of town.

In Ohio the lower thirty-five to forty feet of the Columbus limestone answers admirably to the above description. It is usually a porous brown limestone high in its percentage of magnesium carbonate. The bedding is irregular and frequently almost wanting. Oblique jointing, although not necessarily characteristic, is common. It contains but few fossils all of which are usually but poorly preserved, existing mostly as moulds with occasional casts. Bituminous matter is also usually found, either as thin films between layers or within the rock itself causing an irregular banding. Pockets of calcite crystals are often found and occasionally some gray chert.

The upper sixty-five or seventy feet of the Columbus limestone is usually a crystalline gray limestone high in its percentage of calcium carbonate. It contains great numbers of excellently preserved fossils and considerable gray chert which is also quite fossiliferous. The limestone occurs in even beds which vary from comparatively thin to massive layers. The lower part of this

1. Twenty-fifth Annual Report of the Department of Geology and Natural Resources of Indiana. (1900), pp. 533-536.

2. Ibid. pp. 535, 536.

portion of the formation in central Ohio includes a fossil coral reef which is frequently very pronounced.

The corresponding formation in southern Indiana is the Jeffersonville limestone which agrees so closely in appearance with the upper portion of the Columbus limestone that specimens taken from the Speed quarries near Sellersburg Indiana could not be distinguished from samples taken from the quarries at Marble Cliff. This identity is not merely lithological but extends also to the fossil content. The abundant species of the two limestones are the same and even some of the zones known here in Ohio [Spirifer acuminatus (Conrad), Spirifer gregarius Clapp, coral, etc.] can readily be located. The coral zone or fossil coral reef at Jeffersonville is on a far grander scale than the similar zone known in the Columbus limestone but it seems to occupy the same horizon or so nearly the same as to suggest that they may have been contemporaneous and probably formed portions of a great barrier reef of the Devonian Sea along the shores of the Cincinnati island.

At the Falls of the Ohio the Geneva limestone has thinned out so that the Jeffersonville becomes the lowest formation of the Devonian and rests directly upon the Louisville limestones (Niagara) of the Upper Silurian.[3] Some writers have included the Geneva with the Jeffersonville limestone on the same ground that the lower portion of the Columbus limestone is retained with the upper in the same formation, viz. identity of fossil content.

The greatest deviation from a nearly perfect identity is to be found between the Sellersburg beds and the Delaware limestone, and yet even here there is that element of similarity which is so evident in the lower deposits. The Sellersburg beds as seen in the quarry of the Standard Cement Company two miles northwest of Charleston, Indiana, along the Baltimore & Ohio Railroad consists of a rather soft blue marly limestone with some shaly layers where much weathered. This portion includes rather more than half of the outcrop. Above this comes a very fossiliferous gray limestone with much soft chalky white chert giving it a mottled appearance. And finally above this comes about two feet of very cherty fossiliferous limestone. Where this formation is not covered by the New Albany black shale the upper part has weathered into a red mud leaving its fossils, many of which are silicified, in a free condition and well preserved.

The Delaware limestone which, from its similarity of fossils and stratigraphic position, corresponds in a general way to this Indiana formation, is too variable to compare favorably distant sections even in Ohio, but its cherty character, blue color, and

3. Ibid. p. 535.

often argillaceous composition as well as the red muds, resulting from extensive weathering, suggest similar conditions of deposition. The approximate correlation of these deposits is then as follows:

INDIANA.	OHIO.
Sellersburg beds	Delaware limestone
Jeffersonville limestone Geneva limestone	Columbus limestone

Northward in both states the line of division between these formations becomes less distinct and in the northern part of the southern Indiana area Dr. Kindle remarks that "associated with the loss of individuality of these two formations occurs a mingling of their two faunas which renders them indistinguishable as separate faunas."[4] To a very limited extent the same is true in Ohio where we find species belonging to the Columbus limestone of central Ohio well up in the Delaware of the northern part, but the preponderance of Hamilton species in the upper formation is even greater in northern than in central Ohio.

The full meaning of these similarities is rather hard to state definitely but they certainly indicate contemporaneous deposition and more or less open communication during their formation, and that the sea bordering the eastern shore ot the Cincinnati land area was not essentially different from that which washed the western shore of the same.

SUCCULENT PLANTS OF OHIO.

NELLIE ELY.

The typical succulents are characteristic of desert and saline regions. There are, however, some fleshy and watery plants which grow in shady and moist places, which show some of the peculiarities of typical succulents. The structures of the xerophytic succulents are highly specialized to harmonize with the usual conditions of the desert. Thickening of the epidermis, the comparatively small number of stomata, the more or less globular form of the stem or leaves in certain species, and the development of special water-storage tissues are among the most striking adaptations to be found in the plant kingdom.

Succulents may be divided into two groups according to their specialized parts. Leaf succulents, in order to restrict transpiration, reduce the surface of their leaves which become more or less cylindrical or globular in shape. These leaves have in their tissusc peculiar cells, called water-storage cells which serve for

4. Ibid. p. 570.

storing up enough water to last from one rainy season to another. These cells are highly specialized, being comparatively large and with thin walls. Many of the typical leaf succulents develop rosettes as in *Sempervivium tectorum.*

Stem succulents have thickened fleshy stems which perform the functions of leaves. Here the stomata are found in the epidermis as in the foliage leaf and the green tissue is contained in the cortex. In many stem succulents the stem becomes leaf-like, or disk-shaped as in Opuntia.

Among the fleshy, watery plants found in our moist woods *Galeorchis spectabilis* is characteristic, while *Adicea pumila* is a good example of the annual plants with delicate watery stems. Probably our most abundant succulent, present almost everywhere in gardens and fields, is the common Purslane, *Portulaca oleracea.*

In the following list, the Ohio plants which might be considered in this connection have been arranged under two heads: first a list of the more typical succulents, and second a general list containing some of the semi-succulent plants present in our flora.

Typical Succulents.

Galeorchis spectabilis (L.) Rydb.
Agave virginica L.
Chenopodium album L.
" glaucum L.
Claytonia virginica L.
" caroliniana Michx.
" perfoliata Doun.
Portulaca oleracea L.
" grandiflora Hook.
Cakile edentula (Bigel) Hook.
Brassica oleracea L.
Sedum telephium L.
" telephioides Michx.
" acre L.
" ternatum Michx.
Sempervivium tectorum L.
Oxalis violacea L.
Opuntia humifusa Raf.

Semi-Succulent Plants.

Chamaelirium luteum (L.) A. Gray.
Allium cepa L.
" cernuum Roth.
" stellatum Ker.
Erythronium Americanum Ker.
Peramium repens (L.) Salisb.
" pubescens (Willd.) MacM.
Adicea pumila (L.) Raf.
Chenopodium leptophyllum (Moq.) Nutt.
Blitum capitatum L.
Salsola tragus L.
Phytolacca decandra L.
Caltha palustris L.
Sanguinaria canadensis L.
Bicuculla cucullaria (L.) Millsp.
" canadensis (Goldie) Millsp.
" eximia (Ker.) Millsp.
Saxifraga pennsylvanica L.
" virginiensis Michx.
Chrysosplenium americanum Schwein.
Impatiens biflora Walt.
" aurea Muhl.
Isnardia palustris L.
Monotropa uniflora L.

EVERGREEN PLANTS OF OHIO.

Grace T. Earl.

The length of life of leaves varies greatly. The leaves of the so-called evergreen trees and shrubs persist through the winter without much apparent change. The leaves of some evergreens persist through only one year, falling off as soon as those of the succeeding year have fully developed. In some conifers the branches always bear leaves formed during several years, although the old leaves may be shed continually.

The cuticle in some evergreen plants is so very highly developed that the outer wall of the epidermal cells is many times thicker than the inner wall, as in the case of Pines and Christmas Holly. The same is true of evergreen parasites, as, for example, the Mistletoe which lives epiphytically on the bark of trees; and generally the majority of the succulent plants also possess epidermal cells with very thick outer walls. In many plants the cuticular layers are of equal thickness over the whole surface of the leaf and this is common especially in the case of the smooth, shiny, leathery leaves. But the formation of a thick cuticle on the epidermis is not a peculiarity of evergreen leaves, for there are some in which the outer wall of the epidermal cells is not at all or only very slightly thicker than the inner. In various evergreens anthocyan is developed which causes the leaves to take on a red color at the approach of cold weather; as is the case in some species of Sedum.

Evergreen leaves must have special adaptations to overcome the effects of freezing since their delicate tissues are exposed to very low temperatures in our latitude. At a freezing temperature vapor is given off from the protoplasm into the inter-cellular spaces where ice crystals are formed. The frozen tissue shows between the ice masses dense areas composed of the collapsed cell-walls packed closely together. This condition is very noticeable in frozen buds and the bark of hardy trees, and sometimes the cells appear entirely disorganized, but on thawing they again expand by taking up water and the normal turgidity is restored. Some evergreen leaves are so organized that they are able to survive the periods of drought or frost of one or even several years without injury.

A number of kinds of rosettes are evergreen or nearly so in Ohio. Some biennial rosettes as the Verbascums do not freeze entirely even during the coldest weather. Among the more hardy pereninal rosettes may be mentioned the species of Senecio, Taraxacum, and Achillea. Such plants as *Poa pratensis*, *Lonicera japonica*, and *Nepeta cataria* may be included among the plants

which partly withstand freezing; while the *Glechoma hederacea* and some species of Lamium are to be classed among the most hardy of our herbaceous perennials.

The Ohio Evergreens may be classed as follows:

EVERGREEN CONIFERS.

Pinus strobus L.
" virginiana Mill.
" echinata Mill.
" rigida Mill.
Larix laricina (Du Roi) Koch.
Tsuga canadensis (L.) Carr.
Thuja occidentalis L.
Juniperus communis L.
" virginiana L.
Taxus canadensis Marsh.

EVERGREEN WOODY DICOTYLS.

Phoradendron flavescens (Pursh.) Nutt.
Berberis aquifolium Pursh.
Cotoneaster pyracantha (L.) Spach.
Ilex opaca Ait.
Ledum groenlandicum OEder.
Rhododendron maximum L.
Epigaea repens L.
Linnaea americana Forbes.
Kalmia angustifolia L.
Kalmia latifolia L.
Andromeda polifolia L.
Chamaedaphne calyculata (L.) Moench.
Gaultheria procumbens L.
Arctosaphylos uva-ursi (L.) Spreng.
Chiogenes hispidula (L.) T. & G.
Oxycoccus oyxcoccus (L) MacM.
" macrocarpus (Ait.) Pers.

EVERGNEEN FLESHY HERBACEOUS PLANTS.

Sedum telephium L.
" telephioides Michx.
" acre L.
Sedum ternatum Michx.
Sempervivium tectorum L.
Opuntia humifusa Raf.

EVERGREEN HERBACEOUS PLANTS.

Aplectrum spicatum (Walt.) B. S. P.
Alsine media L.
Coptis trifolia (L) Salisb.
Hepatica hepatica (L.) Karst.
Trifolium repens L.
Malva rotundifolia L.
Pyrola rotundifolia L.
" elliptica Nutt.
" uliginosa Torr.
" asarifolia Michx.
" secunda L.
Moneses uniflora (L) A. Gray.
Chimaphila maculata (L.) Pursh.
" umbellata (L.) Nutt.
Vinca minor L.
Trientalis americana (Pers.) Pursh.
Prunella vulgaris L.
Lamium amplexicaule L.
" maculatum L.
" album L.
Mitchella repens L.

CERTAIN MOUNDS AND VILLAGE SITES IN OHIO.

The Ohio State Archaeological and Historical Society has published an important volume with the above title by William C. Mills, curator and Librarian of the society. The work consists of four special papers reprinted from the Ohio Archaeological and Historical Quarterly together with a preface and complete indices. The papers are entitled as follows: "Excavations of the Ardena Mound," "Explorations of the Gartner Mound and

Village Site," "Explorations of the Baum Prehistoric Village Site," and "Explorations of the Edwin Harness Mound." These reports are handsomely illustrated and show not only the artifacts discovered but also the progress of the work of excavation and the various burials and finds in situ.

The society is to be congratulated on the quality of the work being accomplished by its able curator. These monographs show what the character of future explorations and excavations in our state must be if we are to reap the full benefit of the rich archaeological material within our boundaries. The old, haphazard method of digging a trench or hole into a mound was of little value and usually gave wrong or imperfect impressions of the actual nature of the works investigated. It would be an unfortunate circumstance if lack of funds were to hinder the further progress of the work and it is to be hoped that the society will obtain the proper financial assistance to enable Prof. Mills to carry on these investigations on a much larger scale in the future than has been possible in the past.

J. H. S.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, April 7, 1907.

The April meeting of the Biological Club was called to order by the president in Orton Hall.

The paper of the evening was read by Professor Kellerman on his trip to Guatemala. He showed a map of the country, also stating that it is about one and one-half times as large as the state of Ohio.

Many of the volcanoes of the country were visited. These are from eight thousand to thirteen thousand feet high and built up of cinders and ash. The vegetation is dense near the base with a bald cone at the top.

The flora near the top of the different volcanoes is quite similar; but that inside the craters differs somewhat.

Mr. Hambleton gave some observations he had made on the yellow-bellied sap-sucker making holes into a maple tree and drinking the sap.

J. N. FRANK, *Secretary.*

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AGGRADATION AND DEGRADATION OF VALLEYS.

A E MOODY.

It is the purpose of this paper to show what a river can do toward filling and degrading its valley, to discuss the conditions favorable to such work, and to briefly describe the resulting land forms. The paper is based on an experiment which was conducted at Ohio State University during the Winter of 1907 as a part of the work in Geology 21—a course in advanced physiography.[1]

A watertight box, eighteen feet long, two feet wide and sixteen inches deep, was constructed; and then with weak cement a mature valley was built in the box. The valley walls rose on the sides of the box about five inches, and in the center the construction was about one inch deep. Fig 1. Spurs alternately entered the valley from opposite sides. Fig. 2. The cement covered the entire bottom of the box except about one and one-half feet of the lower end which was left open for a catchment basin, where delta formation was studied. The upper end of the cement valley was covered with a pile of fire clay upon which played a fine spray.

At the lower end of the box was an elevated plug perforated so as to let out the water above a certain height. This outlet could be adjusted by changing the length of the plug, so that the lake of accumulated water could be given any desired depth.

A jack screw placed under the box about thirteen feet from the mouth of the stream permitted regulating the slope of the valley. Ordinary three-quarter inch rubber hose and a garden nozzle connected with the city water pipes furnished the spray. With varying city pressure frequent adjustment of the nozzle was necessary to keep a fairly uniform stream.

1 The author desires to thank Dr. Hubbard, under whom the course was taken, for suggestions and criticisms both in the laboratory work and in the preparation of this report.

Aggrading and Degrading.—When the first experiment began, the screw was raised about one inch, which gave a slope of one inch to thirteen feet, or thirty-four feet per mile, equivalent to about one-third of one degree. This is a very steep slope for a stream but the smallness of our stream made it necessary, and even yet the larger particles of clay were only moved a short distance from the heap and that with marked difficulty. Except near the clay pile almost no aggrading at all was done. So the screw was turned up about one-half inch higher which increased the slope to fifty feet per mile. This seems like an enormous grade yet the stream still aggraded its lower valley with difficulty. In fact the stream increased its own slope to more than two inches in thirteen feet by distributing its sediment thicker near the pile of clay. If we could have given the stream more time, of course it would ultimately have aggraded its whole course without either uplift.

The supply of clay was repeatedly replenished that the stream might be constantly taxed to its utmost, and aggradation proceeded. The clay was considerably sorted by the stream. With an uniform slope and a shallow stream. as an aggrading river must be, the larger particles suffered many halts as they were rolled along or dragged on the bottom. While stopped, they served as catchers for other particles which would often accumulate around them. Most of the larger pieces found permanent lodgment before they attained half the journey to the lake and hence the delta built during aggradation consisted largely of very fine material.

The group of particles temporarily or permanently retained in the channel developed into a sandbar dividing or deflecting the water, and causing it constantly to seek new courses. Six observations of the stream were made in less than one hour and during each interval decided changes occurred. Figs. 3–8. It thus appears that a stream engaged primarily in aggrading its valley is shallow, constantly filling its own channel and breaking over its banks.

Aggradation went on until the upper valley was filled even above the rock walls but the lower valley did not fill quite so full. In the hope of more nearly filling the lower valley an increasingly higher perforated plug was repeatedly substituted for the first one, which made the water deeper in the lake. The lower valley then filled satisfactorily.

Upon the completion of the filling process, the heap of clay was no longer replenished but other conditions were left unchanged in order to see whether the stream would cut down into its deposits without further change. Erosion began at once, and the sediments were picked up and pushed or rolled along to the lake. Degradation proceeded perceptibly faster in the upper

valley than in the lower. In the latter the stream spread out lazily in a shallow sheet covering nearly the entire width of the valley floor. Here little if any erosion was taking place, because the stream was essentially at base level. Sediments picked up above were transported across this area without modifying the lower valley, and into the lake to extend the delta. As often as the delta was built out to the plug, it was artificially removed. In order to have the lower part of the valley degraded, it was found necessary gradually to lower the plug in the lake, just as, reversing conditions, it was necessary while aggrading the valley to increase its height This done, terraces were formed by the stream's meandering in the lower course, as well as in the upper.

The rock spurs mentioned at first, jutting out into the valley, resembling in perspective the entering spurs from alternate sides of a valley as seen in mature, dissected plateaus, were built to test the theory of "defended cusps" as set forth in a paper by Davis[2] Our results supported his theory perfectly, for while the stream swung back and forth across its meander belt, leaving terraces at the limits of each meander, these terraces were very often destroyed by the next migration until the cutting had reached sufficient depth to discover the rock spurs, when subsequently all terraces, higher on the bluffs than the spur encountered, were preserved Also in many cases terraces down stream from the spurs were sufficiently defended for preservation.

In Fig 9, A, B, and C represent terrace tops, t and m, the ledges encountered by the stream, and n, a continuation of the effective spur seen above. While the stream was flowing on terrace C the ledge t protected terraces B and A from being destroyed

The experiment showed also that the succession of terraces with narrowing strath on each lower level was not due to a decrease in the volume of the stream, for we were careful to maintain a constant stream; and, while there were temporary variations, it is probable that every hour's work was done by about the same quantity of water, and certain that no appreciable decrease in the volume occurred during the degradation process. The terraces were made by the persistent systematic swinging of the stream back and forth across its flood plain. Where the stream encountered the ledges it was restrained in its lateral cutting and each lower level presented a narrower valley than the one above, but where no ledges were met the stream in the end usually undercut the older terraces and destroyed them. The stream in this erosion stage of its work, however, did not change its course nearly so often as it did during the stage of sedimentation suggesting, as has been shown by Griggs,[3]

2 Bull Mus Comp Zool. Harvard 1902 Geol Series Vol V.
3 Bull Amer Geog Soc 1906 Vol. XXXVIII, pp. 168–177.

Aggrading and Degrading.—When the first experiment began, the screw was raised about one inch, which gave a slope of one inch to thirteen feet, or thirty-four feet per mile, equivalent to about one-third of one degree. This is a very steep slope for a stream but the smallness of our stream made it necessary, and even yet the larger particles of clay were only moved a short distance from the heap and that with marked difficulty. Except near the clay pile almost no aggrading at all was done. So the screw was turned up about one-half inch higher which increased the slope to fifty feet per mile. This seems like an enormous grade yet the stream still aggraded its lower valley with difficulty. In fact the stream increased its own slope to more than two inches in thirteen feet by distributing its sediment thicker near the pile of clay. If we could have given the stream more time, of course it would ultimately have aggraded its whole course without either uplift.

The supply of clay was repeatedly replenished that the stream might be constantly taxed to its utmost, and aggradation proceeded. The clay was considerably sorted by the stream. With an uniform slope and a shallow stream. as an aggrading river must be, the larger particles suffered many halts as they were rolled along or dragged on the bottom. While stopped, they served as catchers for other particles which would often accumulate around them. Most of the larger pieces found permanent lodgment before they attained half the journey to the lake and hence the delta built during aggradation consisted largely of very fine material.

The group of particles temporarily or permanently retained in the channel developed into a sandbar dividing or deflecting the water, and causing it constantly to seek new courses. Six observations of the stream were made in less than one hour and during each interval decided changes occurred. Figs. 3–8. It thus appears that a stream engaged primarily in aggrading its valley is shallow, constantly filling its own channel and breaking over its banks.

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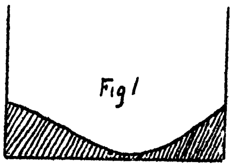

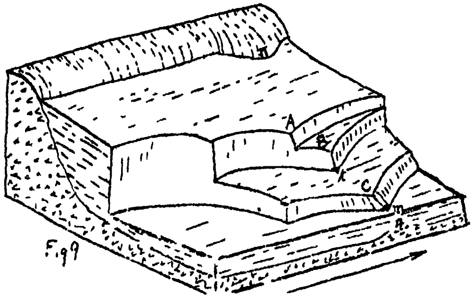

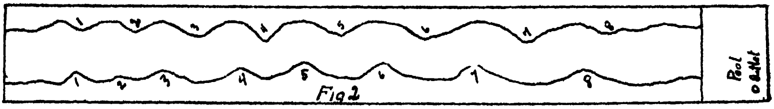

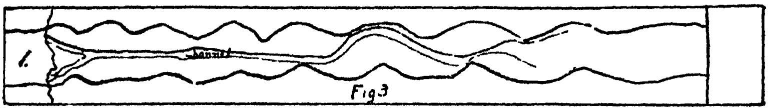

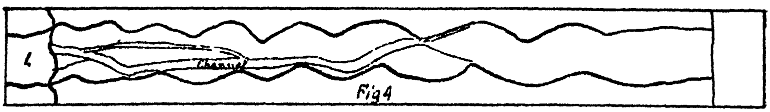

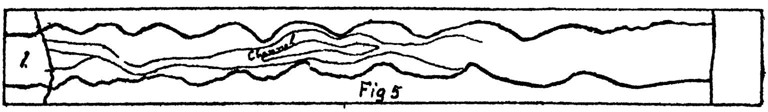

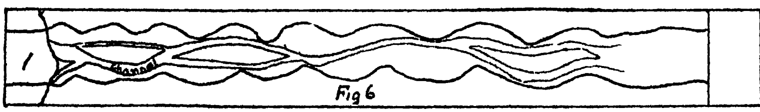

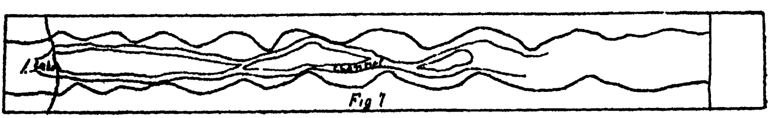

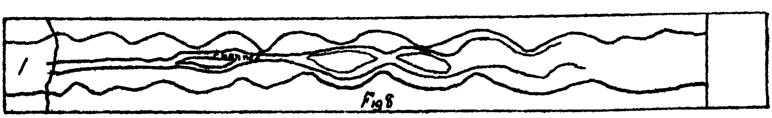

Fig 1. Cross section of box showing form given to the rock filling put in.

Fig. 2. Plan to show the series of spurs 1-8 on each side of the valley, also pool and its outlet.

Figs. 3-8. Successive positions of the channel in the process of aggradation. 1—pile of clay.

Fig. 3 shows position of channels at 3:30 P. M., Feb. 21, '07; Fig. 4, at 3:40; Fig. 5, at 3:45; Fig. 6, at 3:55; Fig. 7, at 4:05; Fig. 8, at 4:15.

Fig. 9. A, B and C are terraces defended at t and m by ledges on the spur n n which has here been encountered by the stream.

that it is largely the deposition of overload in the slackwater sides of streams which engenders meanders and promotes their development. Although the changes in course were so great during deposition, after the supply of sediment was cut off, and erosion began, the stream would go for an hour or more with only slight local changes.

With every swing of the stream from one side of the valley to the other, a thin layre of alluvium was scraped off and a terrace was left. Six distinct terraces were at one time counted on one side of the valley. Terrace fronts were less than half an inch high unless two or more had been combined by cutting out the lower ones. The terraces had a great variety of shapes and directions corresponding to the meanderings of the stream; consequently no two successive fronts were parallel.

Slope, waste, and water supply in relation to eroding power.—The slope as noted above was about sixty-six feet per mile, and even with this steepness, deposition went on actively as long as the stream's maximum capacity for carrying sediment was taxed, but when the pile of clay was no longer replenished active erosion began. The water supply was kept as nearly the same as possible, and the slope was not increased. Since the amount of sediment in the stream was the only factor changed it follows that any change in the habit of the stream may be intimately related to the load.

Let us look, however, for a moment at the other factors in the problem. The supply of water has a great effect in determining the power of a stream. Several times during the experiment the volume of the stream was doubled for a few minutes and it was easy to see that the power of the stream, whatever it was doing, was more than doubled. With an unlimited supply of waste, the stream simply carried more and on the average, carried it farther with the double volume than with the single volume. It did not degrade at all but rather aggraded faster. With no waste at the source, the increased volume accelerated the stream in its degrading; banks were more quickly undercut, and debris was more abundantly and more rapidly hurried down stream. At a time when the supply of clay was limited but the stream was aggrading, a doubling of the volume of water changed the habit of the stream and it began to degrade. In fact, at this time, a volume of water could be used such that the stream neither aggraded nor degraded perceptibly; but that a very slight increase initiated erosion, and a very slight decrease initiated depostion. The balancing of load and power was very accurate and the adjustment so perfect that very slight changes in stream volume were sufficient to unbalance forces and change the stream's habit.

It was noticed, as above stated. that the doubling of the volume more than doubled the power of the stream. If the volume could have been doubled without increasing the velocity, undoubtedly the power would have been little more than doubled, but this is probably impossible; and since increasing velocity so greatly augments power, the marked increase is thus explained.

To test the influence of changes in slope, the steepness was increased and decreased temporarily under various conditions. The results may be summarized as follows· During the early part of the experiment when the stream was constantly loaded to its maximum capacity, decreasing the steepness checked the velocity and power of the stream from the loading point to its mouth, and hence reduced the rate of deposition because the stream could not start as much waste as formerly, when its power was greater, and manifestly could not drop as much either. Under the same loaded conditions with abundance of waste to be picked up at the source, steepening the slope increased deposition instead of initiating erosion because the stream was able to pick up more waste at the start and hence had more to drop along the valley. These results are really not anomalous, but, when the problem is thought out, quite expectable No quantitative tests were made but the general results as here stated were so apparent that we believe the facts are exactly as stated above

When the stream was degrading during the latter part of the experiment, a slight increase in slope increased the rate of degradation and a similar decrease in steepness checked erosion, while more reduction in slope stopped erosion almost completely.

Inasmuch as such changes in slope do not enter into the ordinary field problems of streams we may consider the effects of changes in volume of water and quantity of waste in their general application without considering changes of slope. The experiment was somewhat abnormal to nature in another respect, for in nature waste is not usually fed into a stream, absolutely as fast as the stream will pick it up regardless of variations in the stream's power. In nature, supply of rock waste varies with the volume of water.

Resulting land forms.—The forms resulting from a river's aggrading and subsequently degrading its course are mainly of an ephemeral type. To begin with a constructional plain is formed occupying the valley filled. This plain is composed of loose, more or less systematically stratified materials which, as a rule, do not have time to become much consolidated or cemented before the stream changes its habit and proceeds to send the waste, temporarily rested along the valley, "on its journey to the sea. Terraces are thus carved with their level, often crescentic top plains and their steep, serrate, or cuspate,

front slopes, and below them new-flood plains. Most of the terraces unless defended by rock ledges are subsequently cut out, the flood plain is replaced by a new lower one, and gradually but surely the old valley floor is more or less completely uncovered and the old valley is restored similar to the form which was filled by the accumulating sediments.

The whole cycle of aggradation and degradation constitutes but a little epicycle in the greater round of topographic evolution to which the hard rock lands must submit—a little pleasure trip which the stream takes while it rests from its great work of baseleveling a region. So short-lived are the forms due to these processes that the "eternal hills" do not change much during the entire period of the terrace stage and many epicycles may come and go and leave no record while one turn of the wheel of physiographic development is being made.

CONTRIBUTION TO THE LIFE HISTORY OF CORNUS FLORIDA.*

William Clifford Morse.

This study of the Flowering Dogwood was undertaken at the suggestion of Professor John H. Schaffner and the first material was collected September 26, 1905. When this material was ready for study, it was found that the flower-buds for the next year had already reached an advanced stage of development. Microspores were already formed and the ovule was far developed. Nevertheless, material was taken at intervals of a week during the fall, monthly during the winter, and weekly again during the spring. Through the kindness of Mr. Robert A. Young material was collected, from June until September, 1906, during the writer's absence from Columbus. To him the author takes this opportunity of expressing his thanks.

Schaffner's weaker chrom-acetic acid solution was employed as a killing fluid. Before placing the head of flower-buds in it, however, the four bracts, which during the winter are tightly folded over them, and in the spring form the conspicuous involucure, were removed in order that the solution could better penetrate the buds. Dehydrating and imbedding were performed in the usual manner. Sections were cut from 8 to 18 microns in thickness. The vast majority, however, were 10 or 12 microns. Analin safranin was first used as a stain and afterwards Delafield's Haematoxylin. The latter proved to be much the better and the best results were obtained by overstaining and then clearing for a long period in acid alcohol.

* Contribution from the Botanical laboratory of the Ohio State University No. XXXI.

EARLY STAGES IN THE DEVELOPMENT OF THE FLOWER BUD.

The buds of the same head taken July 21, 1906, showed quite a diversity of stages in development, but the youngest one was practically the very beginning of the flower. The incipient bud arises as a small cylindrical body, from the periphery of the crown of which appear the incepts of the four sepals. These are somewhat transversely flattened cones, the apices of which turn inward (Fig. 1).

In the flower representing the next stage in development, found upon this same receptacle, the incepts of the four petals were seen. These are mere papillae at this time (Fig. 2). They arise at the base of the sepals, on their median side and alternate with them

A third stage of development was also found upon the same head. In this the four incipient stamens (Fig. 3) take up the same position with respect to the petals that the latter did with reference to the sepals. The petals have become much thickened, while their truncated apices are approaching each other.

The gynoecium has its beginning the latter part of July, as shown in figure 4 of material collected on the 28th. A ridge-like ring develops at the base of the stamens. This grows upwards forming the style with a definite stylar canal. In addition to this it may be noted that the apices of the petals have met. These tightly joined petals thus serve as a protection during the winter season.

All of the flowers on a single receptacle collected August 5th showed no further progress in development. Some were even younger than those of the last period.

Flowers of August 11th showed a general development. This was especially manifested in the elongation of the four sets of organs. In addition to this the stamens were becoming differentiated into anther and filament. From the sides of the lower portion of the stylar canal, arise the two incipient ovules (Fig. 5).

Sections of flowers collected August 18th show (Fig. 6) that the basal portion of the original, cylindrical bud has become differentiated as the ovulary. The incipient ovule has bent upon itself and is now growing upwards forming the anatropus type.

DEVELOPMENT OF THE MALE GAMETOPHYTE.

As has already been stated, the stamens begin to be differentiated into a filament and anther as early as August 11th. Internal development has been alike active and the hypodermal archesporial cells of the incipient anther are enlarging. From this time until the next date, August 18th, progress is even more rapid. The archesporial cells have not only divided into the primary parietal and primary sporogenous layers, but these have

in turn divided until there are four parietals, and at least two radial sporogenous layers.

Material collected August 26th showed that in the youngest flowers the three outer parietal layers remain thin and flat while the inner has enlarged and functions as the tapetum. The sporogenous tissue has reached the microsporocyte stage, the nuclei being in synizesis (Fig. 8). Very commonly the chromatin is in a contracted mass on one side of the nuclear cavity while the nucleolus lies free on the other side.

In the oldest flowers of this date the tapetal layer is much broken up into individual cells which are binucleate. The microsporocytes have divided twice in rapid succession without forming a cell wall between them. The result is the spore tetrad within the microsporocyte wall (Fig. 9).

On September 2d the cells of the tetrad had separated into the individual spores. The microspores are somewhat elongated with three double ridges upon their surface.

Commencing September the 8th a gelatinous mass is forming within the microsporangia. On September 24th it had grown much more dense and on the 26th of the same month of the previous year the same condition was present. As this matrix (Fig. 12) remains within the sporangia throughout the winter it no doubt functions as a protection to the microspores and pollen grains. In the spring it begins to dissolve in some sporangia the last of February while in others it remains until the last of April.

At just what date the microspores divide to form the two celled pollen grain (male gametophyte) was difficult to determine because of the deep stain which the gelatinous matrix takes. It was found, however, that the two-celled stage was present December 4th. In this stage, then, they pass the winter, the male gametophyte being developed the fall previous to the blooming of the flower.

THE DEVELOPMENT OF THE FEMALE GAMETOPHYTE.

As has been stated, the incipient ovule makes its appearance about August 11th as a papilla on the wall of the stylar canal. It grows downward and then bends upon itself becoming anatropus August 18th. On this same date the single integument makes its appearance. On August 18th, less than one month after the appearance of the first floral organs, the sepals, the hypodermal archesporial cell is much elongated and contains a large nucleus. This cell becomes the megasporocyte (Fig. 14).

One week later, August 26th, two subsequent cell divisions have occurred. The result is the four megaspores (Fig. 15). Of these the three apical ones are small and non-functional, while the other, functional one is five or six times as large. No cell walls were seen between them.

On September 2d the first division of the functional megaspore has occurred. The result is the two-celled embryo-sac (Fig. 16). The three non-functional megaspores are also apparent as they have not completely disorganized at this time.

A process of dissolution of the nucellus begins about this date which makes the study of the embryo-sac almost impossible. The cells of the sporangium wall begin to break down, leaving fragments of cytoplasm and especially of nuclear material scattered around the sac. This is well shown in the four-celled embryo-sac of September 8th (Fig. 17). It will be noted from this figure that only the apical cells remain intact. The drawing does not show the full amount of disorganizing material, as that of the median portion has been left out in order to show better the four nuclei of the embryo-sac.

From material collected September 24th, 1906, it was not possible to make out the cell stage of the embryo-sac That taken September 26th, 1905, was thought to be the four-celled sac. The ovules of all of the material from October 12th, 1905, to January 29th, 1906 were so dense with disorganizing cells that the stage of the embryo-sacs could not be determined.

Material collected on February 28th contained embryo-sacs in the eight-celled stage. As this is before cell activity begins in the spring it is quite probable that the sac passes the winter in the eight-celled stage. If this is the case then we have the completion of both the male and female gametophytes before the winter rest begins.

Nearly all of the cells of the nucellus are used up by April 30th. This leaves the eight-celled embryo-sac lying within the integument. The two synergids at the apex of the sac are long, slender, pointed cones, and project far up into the micropylar canal (Fig. 20). They are covered by quite a number of irregular longitudinal ridges. This part of the sac is very dense and always takes a deep stain.

On May 7th the epidermal columnar cells of the stigma begin to elongate. By May 14th these same cells are club-shaped. The conducting cells of the stylar canal are cuboidal and are very glandular in appearance.

The eight-celled stage of the embryo-sac persists till about the 21st of May. It has greatly elongated by this time (Fig. 18). The three intipodal cells are very small and lie in the extreme lower end. A very few, widely scattered, nuclei of the nucellus are to be seen in the sac. The definitive nucleus lies close to the egg, just below it in Fig. 18 and by its side in Figs. 19 and 20.

POLLENATION AND FERTILIZATION.

Pollen was collected May 15th, 1906, by simply jarring the flower against the slide. This was the beginning of the shedding of the pollen, for microsporangia of May 14th still contained the

pollen. The grains when shed are very much like the two-celled pollen grain of April 30th (Fig. 13), except they are more elongated, being sub-spindle shaped. In 1907, although the season was somewhat late, the shedding period was about over on May 27th. Fertilization was not observed.

Those flowers which were fertilized, however, could easily be distinguished externally by their increase in size over the others. Of the fertilized flowers there were usually from one to three upon a head. Those receptacles which contained no fertilized flowers were soon shed by the formation of cleavage-planes in the peduncles. Great numbers of the heads thus cut off could be gathered under a single tree.

ENDOSPERM AND EMBRYO.

The first material after the last eight-celled embryo-sac (May 21st) was collected June 12th. By this time there had been a rapid development of the endosperm. This filled the upper third of the embryo-sac, extending up to where the synergids lay. The contorted, double pointed cone of the synergids at this time still retains its characteristic shape. The tissue of the integument is beginning to break down.

On June 20th the endosperm had pushed its way in the upper end of the sac practically to the apex of the cone. In the lower half were a large number of loose endosperm cells. By June 29th, the endosperm had reached a very characteristic arrangement. The upper part forms a cap-like structure, the cells of which are arranged concentrically. The integument is nearly destroyed, there being merely strands of disintegrating cell walls.

In the material of June 12th, 20th and 29th, appeared a short chain of irregular cells whose walls were much thicker than those of the cells of the surrounding endosperm. Whether or not these cells were the young embryo was not determined. The first material which, without question, contained a young embryo was taken July 9th. At this time the embryo is a spherical mass of cells suspended by a suspensor from the cap of endosperm cells (Fig. 21). The endosperm cells do not as yet completely fill the embryo-sac and fragments of the integument cell walls remain.

The embryo has developed rapidly by July 21st. On this date the two cotyledons are present (Fig. 22). Some of the cells are becoming differentiated to form the vascular cylinder. The endosperm completely fills the sac except for the small cavity in which the embryo lies.

The last section was made from material collected July 28th. In this the embryo had become quite large (Fig. 23). The cotyledon, hypocotyl, root tip, root cap, and embryonic tissues were well differentiated. The endosperm, as on July 21st, completely filled the sac.

OHIO NATURALIST *Plate XIV*

MORSE on "Cornus Florida"

A complete embryo was taken from a seed of August 11th. The cotyledons had become much expanded, were much broader than the hypocotyl or stem, and about the same in length.

So far as the writer's knowledge goes very little special work has been done on the Cornaceae. Among the related forms, Ducamp[1] has studied certain Araliaceae and Coulter and Chamberlain[2] give a number of observations on Sium. By some the Rubiales are regarded as close relatives of the Umbellales. Lloyd[3] has made extensive studies on the embryology of this order; but until we have a more detailed knowledge of the related groups it would be useless to make any generalization from the present study of Cornus.

The writer wishes, in closing, to express his thanks to Professor Schaffner who has gone over all the work and given much needed advice and criticism.

Explanation of Plate XIV.

The drawings were outlined with the aid of a camera lucida, and the following optical combinations were used:

Figs 1–7, B & L, 2 oc, $\frac{2}{3}$ obj
Figs 8 and 9, 13–17, B & L, $\frac{1}{2}$ oc, 1-12 obj
Figs 10–12, 18–21, B & L, $\frac{3}{4}$ oc, $\frac{1}{6}$ obj
Figs 22 and 23, B & L, $\frac{3}{4}$ oc, $\frac{2}{3}$ obj

Fig. 1. Longitudinal section of young flower-bud, showing two of the four incipient sepals July 21, 1906

Fig. 2 Longitudinal section of a somewhat older flower-bud of the same head, showing the incipient petals

Fig 3 Longitudinal section of a still older flower of the same head, showing, besides the growing sepals and petals, two of the four incipient stamens

Fig. 4. Longitudinal section of a flower-bud, to show the growth of the ring-like ridge to form the stylar canal of the carpel. July 28, 1906

Fig. 5. Longitudinal section of a flower-bud, to show the growth of the incipient ovule from the side of the stylar canal August 11, 1906

Fig. 6 Longitudinal section of a flower-bud, to show the curving of the lower fourth of the stylar canal around the ovule at right angles to the curvature of the ovule. August 18, 1906.

Fig. 7. A somewhat diagramatic longitudinal section of a flower, showing the four sets of organs in position The two ovules lie in two parallel planes at right angles to the rest of the drawing. The two stylar canals are more or less connected as shown by the dotted portion. January 29, 1906.

Fig. 8. Section of microsporocyte with massed chromatin and large free nucleolus. August 26, 1906.

Fig. 9. Section of a microspore tetrad. August 26, 1906.

Fig. 10. Longitudinal section of part of an anther, showing the epidermis, endothecium, parietal layers, and broken tapetal layer. September 26, 1905.

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1 Ducamp, L. Recherches sur l'embryogenie des Araliacées. Ann. Sci. Nat. Bot. VIII, 15. 311-402. pls. 6–13. 1902.

2 Coulter, J M. and Chamberlain, C. J. Morphology of Angiosperms. 1903.

3 Lloyd, F. E. The Comparative Embryology of the Rubiaceae Bull. Torr. Bot. Club 28 : 1–25. pls. 1–3, 1899. Do. Mem. Torr. Bot. Club 8 : 27–112. pls. 8–15. 1902.

Fig. 11. Typical microspore of same date.

Fig. 12. Longitudinal section of an anther, showing the frothy gelatinous substance about the pollen grains. The anther walls consist of the epidermis, endothecium, two intermediate layers, and the tapetum. January 29, 1906.

Fig. 13. Section of a two-celled pollen grain. April 30, 1906.

Fig. 14. Longitudinal section of an ovule, showing the archesporial cell which is the megasporocyte. August 18, 1906.

Fig. 15. Longitudinal section of an ovule, showing the three small, non-functional megaspores and the large functional one. August 26, 1906

Fig. 16. A longitudinal section of a megasporangium, showing two-celled embryo-sac with the disorganizing nuclei of the three vestigial megaspores. September 2, 1906.

Fig. 17. The ovule cut longitudinally, showing the four-celled embryo-sac with a few of the many disorgianzing nucellar cells shown. September 8, 1906.

Fig. 18. Longitudinal section of an eight-celled embryo-sac, showing the long dense cone, a trace of the egg nucleus lying just below the synergids, the large definitive nucleus below the egg, the three small antipodals and a few of the disorganizing cells of the nucellus. May 21, 1906

Fig. 19. A tip of an eight-celled embryo-sac, showing the contorted ridges on the cone. The egg lies in the median line just below the synergids with the definitive nucleus at its side. May 21, 1906

Fig. 20. Another figure, to show the double point of the cone of the embryo-sac, the definitive nucleus lies at the side of the egg in this one also May 21, 1906.

Fig 21. A young embryo with suspensor below the cap of endosperm tissue. July 9, 1906.

Fig. 22. Outline sketch of a young embryo, showing the cotyledons, root tip and fragment of suspensor. July 21, 1906.

Fig. 23. Outline sketch of an older embryo with cotyledons, stem tip, root tip and root cap. July 28, 1906.

Addition to List of Dragonflies of Canada.*

Under date of June 3, 1907, Mr. E. P. VanDuzee kindly calls my attention to an omission in the paper cited. In the list of papers relating to Canadian dragonflies I omitted Mr. Van Duzee's paper, *List of Dragonflies Taken Near Buffalo, N. Y., Journ., N. Y., Ent. Soc., Vol. V, June, 1897, pp. 87–91,* in which he records the capture of *Anomalagrion hastatum* Say at Point Abino, Ontario. I failed to list this with the other Canadian species.

Bluffton, Ind. E. B. Williamson.

The writer would be pleased to receive reports of any observations on the southward migration of the Monarch Butterfly (*Anosia plexippus*) during the early part of October.

Herbert Osborn.

*Published in Ohio Naturalist, Vol. VII, No. 7, May, 1907, pp. 148–150.

CHECK LIST OF OHIO SHRUBS.

JOHN H. SCHAFFNER.

A check list of Ohio trees was published by the writer in February, 1906, (Ohio Nat. 6 · 457). The present compilation is along the same lines and especial care has been taken to give what at present seems to be the most appropriate English name, in the hope that some progress will be made in establishing a definite system to be used in the state.

The larger, tree-like shrubs have already been listed in connection with the more typical trees; they are, therefore, not included here. The lianas and half shrubs are also excluded. The introduced species are indicated by the letter I after the English name. Of the 127 species listed below, 103 are native and 24 are introduced.

Class, CONIFERAE.
Order, **Taxales.**
Family, *Taxaceae.*

Taxus canadensis Marsh American Yew.

Class, DICOTYLAE.
Subclass, APETALAE.
Order, **Salicales.**
Family, *Salicaceae.*

Salix glaucophylla Bebb. Broadleaf Willow.
" cordata Muhl. Heartleaf Willow
" adenophylla Hook. Furry Willow.
" myrtilloides L. Bog Willow.
" petiolaris Sm. Slender Willow
" humilis Marsh. Prairie Willow. Also var. tristis (Ait.) Griggs.
" candida Fluegge. Hoary Willow.
" sericea Marsh. Silky Willow.
" purpurea L. Purple Willow.

Order, **Myricales.**
Family, *Myricaceae.*

Comptonia peregrina (L.) Coult. Comptonia.

Order, **Fagales.**
Family, *Betulaceae.*

Corylus americana Walt. Common Hazelnut.
" rostrata Ait. Beaked Hazelnut.
Betula pumila L. Low Birch.

Order, **Santalales.**
Family, *Loranthaceae.*

Phoradendron flavescens (Pursh) Nutt. American Mistletoe.

Subclass, CHORIPETALAE.

Order, **Ranales.**

Family, *Berberidaceae.*

Berberis vulgaris L. European Barberry. I.
" aquifolium Pursh. Trailing Mahonia. I.

Lauraceae.

Benzoin benzoin (L.) Coult. Spicebush.

Order, **Rosales.**

Family, *Hydrangeaceae.*

Hydrangea arborescens L. Wild Hydrangea.

Philadelphus inodorus L. Scentless Mock-orange. I.
" grandiflorus Willd. Large-flowered Mock-orange. I.
" coronarius L. Garden Mock-orange. I.

Family, *Grossulariaceae.*

Ribes cynosbati L. Wild Gooseberry.
" uva-crispa L. Garden Gooseberry. I.
" oxyacanthoides L. Northern Gooseberry.
" lacustre (Pers.) Poir. Swamp Gooseberry.
" nigrum L. Black Currant. I.
" rubrum L. Red Currant. I.
" floridum L'Her. Wild Black Currant.
" aureum Pursh. Golden Currant. I.

Family, *Rosaceae.*

Subfamily, *Rosatae.*

Opulaster opulifolius (L.) Ktz. Eastern Ninebark.

Spiraea salicifolia L. Willowleaf Spiraea.
" tomentosa L. Steeple-bush.
" corymbosa Raf. Corymbed Spiraea. I.
" prunifolia Sieb. Bridal-wreath (Spiraea). I.
Sorbaria sorbifoila (L.) A. Br. Mountain-ash Spiraea. I.

Rubus odoratus L. Purple Flowering-raspberry.
" phoenicolasius Max. Wineberry. I.
" americanus (Pers.) Britt. Dwarf Raspberry.
" strigosus Mx. Wild Red Raspberry.
" neglectus Peck. Purple Wild Raspberry.
" occidentalis L. Black Raspberry.
" nigrobaccus Bail. Common High Blackberry.
" frondosus Bigel. Leafy-bracted Blackberry.
" canadensis L. Dewberry.
" baileyanus Britt. Bailey's Dewberry.
" hispidus L. Swamp Blackberry.

Dasiphora frutica (L.) Rydb. Shrubby Cinquefoil.

Rosa setigera Mx. Prairie Rose.
" blanda Ait. Smooth Ro e.
" carolina L. Swamp Rose.
" lucida Ehrh. Glassy Rose.
" humilis Marsh. Low Rose.
" nitida Willd. Shining Rose.
" canina L. Dog Rose.
" rubiginosa L. Sw.etbrier.
" cinnamomea L. Cinnamon Rose. I.
" gallica L. French Rose. I.

Subfamily, *Pomatae.*

Aronia arbutifolia (L.) Medic. Red Chokeberry.
" atropurpurea Britt. Purple Chokeberry.
" nigra (Willd.) Britt. Black Chokeb.rry
Cotoneaster pyracantha (L.) Spach. Fire Thorn. I.

Subafmily, *Drupatae.*

Prunus pumila L. Sand Cherry.
" cuneata Raf. Appalachian Cherry.

Family, *Fabaceae.*

Subfamily, *Papilionatae.*

Amorpha fruticosa L False Indigo.
Robinia hispida L. Bristly Locust. I.

Order, **Sapindales.**

Family, *Anacardiaceae.*

Rhus aromatica Ait. Fragrant Sumac.

Family, *Ilicaceae.*

Ilex verticillata (L.) Gr. Winterberry.

Family, *Celastraceae.*

Enonymus americanus L. American Strawberry Bush.
" obovatus Nutt. Running Strawberry Bush.

Order, **Rhamnales.**

Family, *Rhamnaceae.*

Rhamnus cathartica L. Buckthorn. I.
" lanceolata Pursh. Lanceleaf Buckthorn.
" alnifolia L'Her. Alderleaf Buckthorn.
Ceanothus americanus L. New Jersey Tea.
" ovatus Desp. Smaller New Jersey Tea.

Order, **Parietales.**

Family, *Hypericaceae.*

Ascyrum multicaule Mx. St. Andrew's Cross.
Hypericum kalmianum L. Kalm's St. John's-wort.
" prolificum L. Shrubby St. John's-wort.

Order, **Thymeleales.**

Family, *Thymeleaceae.*

Dirca palustris L. Leatherwood.

Family, *Elaeagnaceae*.

Lepargyraea canadensis (L.) Greene. Canadian Buffalo-berry.

Subclass, HETEROMERAE.

Order, **Ericales.**

Family, *Ericaceae*.

Ledum groenlandicum Oeder. Labrador Tea.
Azalea nudiflora L. Pink Azalea.
" lutea L. Flame Azalea.
" viscosa. White Azalea.
Kalmia angustifolia L. Sheep-laurel.
Andromeda polifolia L. Wild Rosemary.
Chamaedaphne calyculata (L) Moench Leatherleaf.
Epigaea repens L. Trailing Arbutus.
Gaultheria procumbens L. Creeping Wintergreen
Arctostaphylos uva-ursi (L.) Spreng. Red Bearberry.

Family, *Vacciniaceae*.

Gaylussacia frondosa (L.) T. & G. Tangleberry.
" resinosa (Ait.) T. & G. Black Huckleberry.
Polycodium stamineum (L.) Greene. Deerberry.
Vaccinium corymbosum L Tall Blueberry.
" atrococcum (Gr) Heller. Dark Blueberry
" canadense Rich. Canada Blueberry.
" pennsylvanicum Lam. Dwarf Blueberry.
" vacillans Kalm Low Blueberry.
" pallidum Ait. Pale Blueberry.
Chiogenes hispidula (L.) T & G Creeping Snowberry.
Oxycoccus oxycoccus (L.) MacM Small Cranberry.
" macrocarpus (Ait.) Pers. Large Cranberry.

Subclass, SYMPETALAE HYPOGYNAE.

Order, **Gentianales.**

Family, *Oleaceae*.

Syringa vulgaris L. Lilac. I.
Ligustrum vulgare L. Privet. I.

Order, **Polemoniales.**

Family, *Solanaceae*.

Lycium vulgare (Ait. f.) Dun. Matrimony Vine. I.

Subclass, SYMPETALAE EPIGYNAE.

Order, **Umbellales.**

Family, *Cornaceae*.

Cornus circinata L'Her. Roundleaf Dowgood.
" amomum Mill. Silky Dogwood.
" stolonifera Mx. Red-osier Dogwood.
" candidissima Marsh. Panicled Dogwood.

Order, **Rubiales.**

Family, *Rubiaceae*.

Cephalanthus occidentalis L. Button-bush.

Family, *Caprifoliaceae.*

Sambucus canadensis L. Common Elderberry.
" pubens Mx. Red Elderberry.
Viburnum alnifolium Marsh. Hobblebush.
" opulus L. Cranberry-tree.
" acerifolium L. Mapleleaf Arrow-wood.
" pubescens (Ait.) Pursh. Downy Arrow-wood.
" dentatum L. Arrow-wood.
" molle Mx. Softleaf Arrow-wood.
" cassinoides L. Withe-rod.
" lantana L. Wayfaring-tree. I.
Symphoricarpos racemosus Mx. Snowberry.
" pauciflorus (Robb.) Britt. Low Snowberry.
" symphoricarpos (L.) MacM. Coralberry.
Lonicera oblongifolia (Goldia) Hook. Swamp Fly-honeysuckle.
" ciliata Muhl. American Fly-honeysuckle.
" xylosteum L. European Fly-honeysuckle. I.
" tartarica L. Tartarian Bush-honeysuckle. I.
Diervilla diervilla (L.) MacM. Bush-honeysuckle.

THE CHESTNUT-SIDED WARBLER NESTING AT JEFFERSON, ASHTABULA CO., O.

ROBERT J SIM

On June 26 (1907) Miss Mary I. Hoskins discovered the nest of a pair of Chestnut-sided Warblers in a bit of woodland not more than a mile north-east of town. The locality is an ideal one for warblers. There are perhaps fifteen or twenty acres in the wooded tract. Tall second-growth timber predominates, but here and there are towering parent trees of White Oak, Tulip, Cucumber, Beech, Hickory and Maple. The west side is mostly clear of under-brush, but in some parts of the piece are rank growths well sorted into colonies of Beech, Maple and Oak sprouts. In about the center a small clearing has been made and here the Blackberry, Spice-bush and Red-berried Elder run riot.

In this place a female Chestnut-side was noticed passing thru the brush. A short search resulted in the discovery of the nest placed two feet above the ground among some leafy blackberry stems near the foot of a large beech. The naked cowbirdling in the nest was as large as the two young warblers together, and these were all but smothered by him. He was removed. The mother-warbler remained within a few feet of her home, chirping anxiously and fluttering about with spread wings and tail.

The male also appeared upon the scene but was not so bold and soon retired to the tree-tops.

On July 3rd, I paid the birds a second visit. The young birds had developed considerably. I stationed myself about fifteen feet from the nest, and in five minutes the female bird began feeding the young. Once she shook a lepidopterous larva (more than an inch long) from a curled-up leaf, and after pinching it for a while, took it to the nest

On another occasion a large *Tipula* was brought. The young were fed, in fact, every three or four minutes, then the mother would brood them for a short time. The male did not appear, but was occasionally heard singing up in the trees around the clearing.

On the fourth of July my folding chair was set six feet from the nest, and there I sat taking notes while the warbler—always the female—flitted about me, sometimes all but alighting upon my shoulder or foot. All the insects that were required were found within ten feet of the nest. I suppose they are so numerous in the woods that in every spot a new supply comes on daily.

The next morning a camera was taken to the chestnut-side's district, with the hope that a family group photo might be made. Nothing doing. The young were gone. Doubtless they were in the vicinity for the old bird flitted about chipping as usual, but I could not find them.

A photo of the nest was made, then I gave my atteniton to the Hoodeds, the Ceruleans—and the mosquitoes.

Annual Meeting of the Ohio Academy of Science.

The Seventeenth Annual Meeting of the Ohio Academy of Science will be held at Miami University, Oxford, Ohio, on November 28, 29 and 30, 1907. All that are interested in the work of this organization are invited to attend the meetings. Members are requested to send subjects, that they wish to present, to the Secretary, Professor L. B. Walton, Gambier, Ohio, not later than November 23rd.

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CONTRIBUTION TO THE LIFE HISTORY OF ASIMINA TRILOBA.*

WILLIAM B. HERMS.

The material for this study was collected in the outskirts of Columbus, Ohio, along the banks of the old canal, where the papaw grows quite abundantly. The young buds were killed in a one per cent. solution of chromo-acetic acid, within ten to twenty minutes after collecting them. Before killing, the sepals and petals were removed to secure better penetration.

The first collection was made Sept. 30, 1905, and continued weekly until the middle of December, when collections were made every two weeks until the middle of February, at which time weekly collections were again resumed. During the early part of June collections were made twice per week. The entire ovulary was imbedded in paraffin and serial sections cut ten microns thick with a rotary mircotome. Several staining methods were emlpoyed, of which the double stain anilin-safranin followed by gentian violet was the best for the early work on the megaspores and microspores, while Delafield's Haematoxylin gave the best results for the later stages, e. g., development of the embryo sac and late microspores.

The work was carried on in the Botanical Laboratory of the Ohio State University under the direction of Professor J. H. Schaffner to whom the writer wishes to express his thanks for advice and helpful criticism freely given.

OVULES AND MEGASPORES. The first sections cut of Sept. 30, 1905, (Fig. 1), showed an undifferentiated condition of the ovules. No cell could be distinguished that might eventually give rise to the archesporial cell. This undifferentiated condition is retained throughout the winter as is evident from Fig. 2 (Jan. 6). The first sections showing the archesporial cell, which is

* Contributions from the Botanical Laboratory of the Ohio State University, XXXII.

hypodermal, were of April 14 (Fig. 3). No integuments have as yet appeared. From this time on development and differentiation is rapid. Fig. 4 (April 21) shows the archesporial cell divided into parietal cell and megasporocyte. The parietal cell has divided into two by a vertical wall, and the incipient integuments are now visible as may be seen in Fig. 5. This figure also shows a further division of the parietal layer. By April 28 (Fig. 6) the megasporocyte has divided into four degaspores which are arranged in a row, the three upper of which at once begin dissolving. An extensive parietal tissue is formed by this time (Fig. 7). In Figs. 7 and 8 the outer megaspore is divided by a vertical wall, while in Fig. 6, the division is horizontal. This latter condition was the more commonly observed. The arrangement of the megaspores in a more or less perfect tetrad indicates a rather primitive position of the plant under consideration. The same condition was noted by Surface[1] for Sanguinaria canadensis and by Shreve[2] for Sarracenia purpurea.

EMBRYO SAC. The functional megaspore divides about April 28, forming the two-celled embryo sac (Fig. 9). The non-functional megaspores are gradually dissolving. This date also shows some ovules having embryo sacs with conjugating polar nuclei, the three antipodals, synergids and egg (Fig. 10). The synergids are arranged in such a manner that together with the egg they form a sort of tripod (See Figs. 10, 12 and 13). The embryo sac elongates very greatly during the next week or two (Fig. 11) and the antipodals come to lie close together in the base of the sac and are still plainly visible in sections of May 19 (Fig. 15), though beginning to degenerate. This evanescent condition of the antipodals is very different from what would be expected in Ranunculacae.

The polar nuclei occupy a characteristic position but remain side by side for an unusually long time, apparently about three weeks, before conjugating (Figs. 10 and 11). The various structures of the embryo sac are all clearly differentiated by staining, so that interpretation is not difficult.

Together with the long period during which the polar nuclei remain in contact without fusion, should be noted the equally long time that the oospore remains undivided after the beginning of the endosperm formation. May 19 (Fig. 16) shows the oospore still undivided, but there are already formed a dozen or more endosperm cells.

ENDOSPERM AND EMBRYO. In sections of May 19 (Fig. 12) the first endosperm wall was observed. This wall is transverse and divides the sac into two equal parts. The endosperm nuclei

1. Surface, Frank M., '05.—Contribution to the Life History of Sanguinaria canadensis. Ohio Nat. 6 : 1, 1905.
2. Shreve, Forrest, '06.—The Development and Anatomy of Sarracenia purpurea. Bot. Gaz. 42 : 107, 1906.

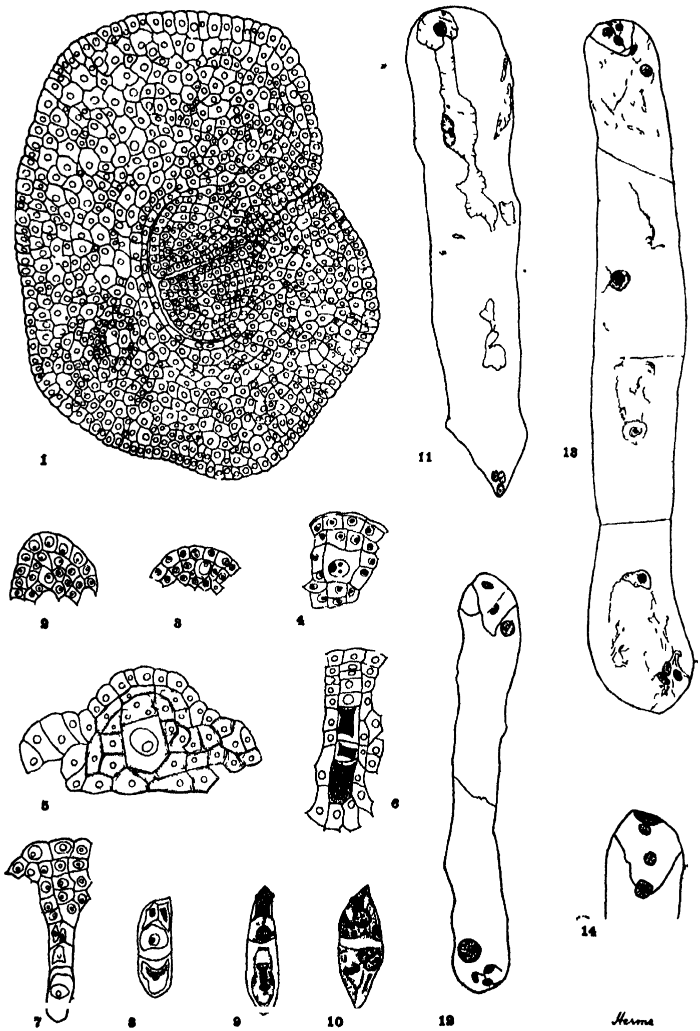
now divide rapidly as indicated by Figs. 13 and 16, forming a linear series of endosperm of about a dozen cells, with transverse walls, when a vertical wall appears in the base of the sac (Fig. 16). The endosperm grows rapidly until there is formed a narrow strip throughout the length of the seed, the upper end of which is shown in Fig. 17. The order of the endosperm division was not determined but the indications are that the divisions are not basipetal, as Strasburger[3] found for Ceratophyllum, though the first division of the sac into two halves is similar. Figs. 12, 13 and 16 show what has taken place. Apparently the endosperm divides into two cells, each of which divides again and so on until perhaps a dozen cells have been formed in a linear series when vertical division takes place as already noted.

The germination of the oospore is very much delayed, as has already been pointed out. The first wall is transverse and the subsequent divisions quite irregular. The embryo in the mature seed is very minute and imperfectly developed, the greater part of the seed being occupied by a peculiar wrinkled tissue of the wall of the ovule. Fig. 17 (June 10) shows the upper end of the endosperm column with the minute embryo and remnants of the pollen tube.

MICROSPORANGIUM AND MICROSPORE. The first sections made (Sept. 30) showed the differentiation of the microsporophylls each with four microsporangia. Fig. 18 shows one of the microsporangia in which may be seen a number of microsporocytes in cross section, of which two show a somewhat greater development and more prominent nuclei. This condition is not altered throughout the winter as is shown by Fig. 19 of Jan. 6. Fig. 20, of March 10, shows the growth of the microspores at that date, being the earliest to show what is really taking place. It can be seen at once that some of the sporogenous tissue is breaking down and that only a few microsporocytes (usually two in cross section) are building up and growing at the expense of the surrounding cells. Fig. 21 (April 14) is interesting since here may be seen the differentiation of a bridge of tissue between the microsporocytes. The nuclei of these cells have divided as well as those of the surrounding tapetal cells. By April 21 (Fig. 22) the spore tetrads are formed and the sterile tissue in the sporangium is dissolving rapidly. By April 28 (Fig. 23) the sterile tissue and tapetum has completely dissolved. May 5 (Fig. 24) the pollen grains are ready to be shed, the generative and tube nuclei being formed.

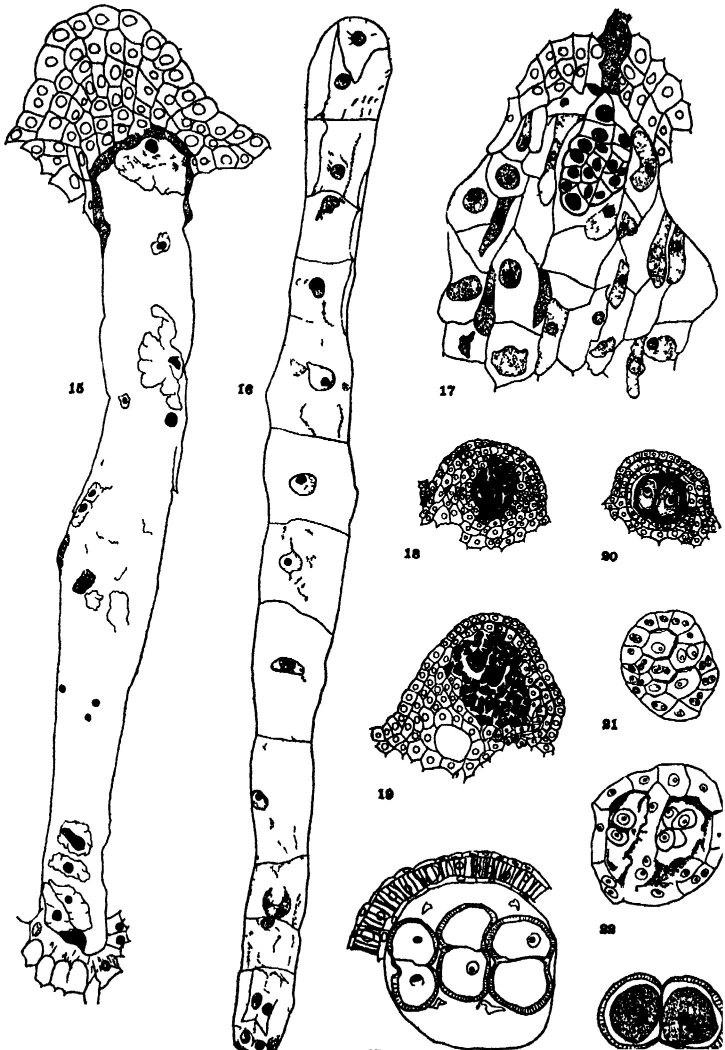
3. Strasburger, Eduard, '02.—Ein Beitrag zur Kenntniss von Ceratophyllum submersum und phylogenetische Eroerterungen. Jahrb. f. wiss. Botanik. 37 : 477–526. Pls. 9–11. 1902.

OHIO NATURALIST. *Plate XV.*



HERMS on "Life History of Asimina trilaba."

OHIO NATURALIST. *Plate XVI.*



HERMS on "Life History of Asimina triloba."

SUMMARY.

1. The archesporial cell of Asimina triloba remains undifferentiated during the winter, no differentiation being apparent until about April 14.
2. Tetrad megaspores are of rather frequent occurrence.
3. The parietal layer of the ovule develops greatly.
4. The great elongation of the embryo sac is striking.
5. The length of time that the polar nuclei remain in contact is quite unusual (three weeks and over).
6. The evanescent condition of the antipodals is rather unexpected in this farm.
7. The oospore remains undivided relatively long (between three and four weeks).
8. Endosperm forms in a peculiar manner. The first wall is transverse and divides the sac into two equal parts. The formation of a linear series of endosperm now follows, continuing until about a dozen cells are formed when a vertical division begins at the base of the sac.
9. The embryo is minute and imperfectly developed, even in the seed.
10. Comparatively few large microsporocytes are formed.
11. There is a peculiar development of sterile tapetum-like tissue in the microsporocytes.
12. The pollen grains are ready to be shed by May 5.
13. The study shows that Asimina triloba differs in its development from the Ranunculaceae and Papaveraceae and,
14. Resembles the Ceratophyllaceae more or less closely in its development.

DESCRIPTION OF PLATES.

All drawings were made with the use of the camera lucida at table distance. A Bausch and Lomb microscope was used with the combination lenses indicated with each description.

FIG. 1.—Sept 30, 1905. Cross section of ovulary showing undifferentiated ovules. B. & L. 1 in.–$\frac{1}{6}$ in.

FIG. 2—Jan 6, 1906. Section of ovule showing undifferentiated condition still present at this date. B. & L. 1 in.–$\frac{1}{6}$ in.

FIG. 3.—April 14, 1906. Tip of ovule showing the differentiated archesporial cell. B. & L. $\frac{1}{2}$ in.–$\frac{1}{6}$ in.

FIG. 4.—April 21, 1906. Shows archesporial cell divided into parietal cell and megasporocyte. The parietal cell is divided into two by a vertical wall. B. & L. $\frac{1}{2}$ in.–$\frac{1}{6}$ in.

FIG. 5.—April 21, 1906. Tip of ovule showing incipient integuments and further division of parietal layer. B. & L. 1 in.–$\frac{1}{12}$ in oil immersion.

FIG. 6.—April 28, 1906. Shows four megaspores arranged in a row; the three upper ones are dissolving. B. & L. $\frac{1}{2}$ in.–$\frac{1}{6}$ in.

FIG. 7.—April 28, 1906 Shows extensive parietal tsisue and four megasporocytes, the two outer divided by a vertical wall. B. & L. $\frac{1}{2}$ in.–$\frac{1}{6}$ in.

FIG. 8.—April 28, 1906. Same as Fig. 7.—Four megaspores, the two outer ones divided by a vertical wall. B. & L. $\frac{1}{2}$ in.–$\frac{1}{6}$ in.

FIG. 9.—April 28, 1906. Two celled embryo sac with three megaspores above. B. & L. ½ in.–⅛ in.

FIG. 10.—April 28, 1906. Shows conjugating polar nuclei, three antipodals and egg apparatus. B. & L. ½ in.–⅛ in.

FIG. 11.—May 19, 1906. Mature embryo sac showing conjugating polar nuclei, the egg and antipodals. B. & L. ½ in.–⅛ in.

FIG. 12.—May 19, 1906. Embryo sac with two endosperm cells, separated by a wall, also the vanishing antipodals, oospore and synergids. B. & L. ½ in.–⅛ in.

FIG. 13.—May 19, 1906. Embryo sac showing three endosperm walls, three vanishing antipodals and complete egg apparatus. B. & L. ½ in.–⅛ in

FIG. 14.—May 19, 1906. Showing oospore with one endosperm nucleus and remnants of pollen tube. B. &. L. ½ in.–⅛ in.

FIG. 15.—May 26, 1906. Embryo sac without definite endosperm walls and with dissolving antipodals. (The delicate walls have probably been destroyed by the technique.) B. & L. ½ in.–⅛ in.

FIG. 16—May 19, 1906. Embryo sac showing thirteen endosperm cells, the lowest one divided by a vertical wall. The egg is still in the one celled stage and the antipodals are still distinct. B. & L. ½ in.–⅛ in.

FIG. 17.—June 10, 1906. Showing young embryo surrounded by endosperm tissue. The remnants of the pollen tube are visible. B. & L. ½ in.–⅛ in

FIG. 18.—September 30, 1905. Section of sporophyll showing microsporocytes, of which two are somewhat larger than the others. B. & L. 1 in.–⅛ in.

FIG. 19.—Jan. 6. 1906. Same as Fig. 18, except that there is a very slight enlargement of the two microsporocytes. B. & L. 1 in.–⅛ in.

FIG. 20.—March 10, 1906. Showing two microsporocytes developed and others undeveloped. B & L. 1 in.–⅛ in.

FIG. 21.—April 14, 1906. Microsporocytes with a bridge of sterile tissue between them. Note the dividing nuclei of the sterile tissue, also of the tapetal layer. B. & L. 1 in –⅛ in.

FIG. 22.—April 21, 1906. Spore tetrads. On the one side only two are visible. The sterile tissue surrounding the tetrads is dissolving. B. & L. 1 in.–⅛ in.

FIG. 23.—April 28, 1906. Spore tetrad. The sterile tissue and tapetal layer have completely dissolved. B. & L. ½ in.–⅛ in

FIG. 24.—May 5, 1906. Pollen grains with generative and tube nuclei. B. & L. ⅛ in –½ in.

COMPENSATORY GROWTH IN PODARKE OBSCURA.*

SERGIUS MORGULIS, A. M.

The idea that when a lost part is being regenerated by an animal, the whole organism of the latter, and not merely the amputated surface is actively engaged in this process of restoration was kept in disrepute. The main objection advanced by the opponents of this idea was that it is at the cut surface only where the histological process of regeneration is to be observed in the appearance of mitotically or amitotically dividing cells. The writer, however, was forced to the opposite view through some studies of the rate of regeneration, but could not produce sufficient evidence in favor of his view from those studies. Since

* This and the following note were read before the Ohio Academy of Science at its Seventeenth Annual Meeting in Oxford, Ohio.

that time a number of experiments and observations conducted during last summer, as well as the extremely interesting facts presented before the section of Experimental Zoology of the Seventh International Zoological Congress in Boston by Dr. Prizbram, seem to offer a proof of the idea that the mutilated organism as a whole partakes in the regeneration of a lost organ.

I wish to speak here mainly of my observation on the compensation which takes place in case of posterior regeneration in Podarke obscura. This is a small marine polychaet, found abundantly at Woods Hole, in the Eel-pond on sea-weeds. The worms have a chitinous layer over their dorsal surface, the color of which grades from seal-brown to a very light shade of yellow, but in a few exceptional cases it is entirely wanting.

If the posterior half of the worms be removed, a new tail will regenrate in course of some eight days. This regenerated tail will be as a rule devoid of any chitinous covering, and the tissue will therefore be quite translucent. This regenerated tail will soon, however, acquire a chitinous layer over its dorsal surface, which will gradually increase in thickness. As this process of thickening is going on the translucence of the newly regenerated tissue is being lost, and the covering also becomes darker and darker.

The interesting thing to be observed in this connection is, that while this surface layer is formed on the regenerated tail, another phenomenon exactly opposite to the one just described occurs bringing about a gradual thinning out of the chitinous layer over the dorsal surface of the old piece. This gradual thinning out, which results finally in a complete exposing of the underlying tissues beneath, may start either on the part of the old piece nearest to the regenerated tail, or on the part furthest removed from it or even on the left and right sides of all the old segments.

These two processes, the thinning out of the chitinous layer on the old tissue, on one hand, and its thickening on the regenerating tissue on the other hand, will continue until both parts, the old and the new are covered by a continuous layer of uniform thickness. The process, however, may not be brought to an end even at this stage, and go on until the dorsal covering on the new tail would become much thicker and consequently darker, than that on the old part. This shifting of the chitinous material from the old over to the new part will proceed still further, ultimately leading to the formation of a seal brown covering over the new, regenerated tissue and leaving entirely naked so to speak the old tissue. This condition is exactly the reverse of that with which we started when the old part was all coated with a seal brown layer of chitin, and the regenerated part was all naked. First the old tissue was thickly clothed with chitin, and

the regenerated tissue perfectly transparent; now it is the regenerated tissue which is all covered up with chitin and the old tissue became transparent.

We have here thus a case of transmission of materials from all parts of the old tissue to provide for the building up of the new tissue, and, as we mentioned above, the material may come either directly from the region near the cut surface or from the remotest portions.

In those worms where the chitinous covering was absent before the operation, the dorsal surface of the new, regenerated tail also remained free of such a covering. The same thing happened when worms, which bore a layer of chitinous material on their dorsal surface, were subjected to the action of a 0.0001 per cent. solution of strychin, in which case the chitin disappeared from the old part, and has never been deposited in the regenerated part, indicating that the regenating organ is dependent on the old tissue for its building material.

This fact here related, as well as others of which I cannot speak now, point to the assumption that it is the organism as a whole and not the exposed, cut surface of the organism that is concerned with the regeneration of the lost tissue.

REGENERATION AND INHERITANCE.

SERGIUS MORGULIS, A. M.

When a gold fish which happens to have a black band across its tail regenerates a new tail with the black band in the same position, after the latter has been removed, we may speak of this in a general way as being a case of inheritance through regeneration. In the same loose sense we may speak of the regeneration of an antenna instead of an eye, in certain crustaceans, and of the regeneration of antennae instead of legs in insects as cases of reversion.

Such cases, however, cannot be considered as hereditary phenomena *sensu strictu*, in the same sense as the term is being used to indicate a tranmission of a character from one individual to another. It is only through a comparative study of the regeneration of regenerated tissue and of that of the original old tissue by which the regenerated tissue was produced, that we may get a clue as to the transmission of characters in the regenerative process.

The great difficulty which presents itself in such a comparative study lies in the fact that while a great many animals do possess the power to regenerate an amputated portion or organ of their body, the lost organ and also the new organ regenerated in its stead do not possess the power to regenerate the whole animal

when detached from the animal's body. Thus while a part of an animal's organism may become regenerated, a new animal is not produced in this process of regeneration. Even in those cases where fragments of the animal's body give rise to new animals. it is not always possible to obtain a new individual which would be formed entirely of regenerated tissue, and which would in its turn be ready to undergo an operation with subsequent regeneration.

Of all regenerating animals the fresh water oligochaet, Lumbriculus, presents probably the best opportunity for such a comparative study, since every piece of the worm, in fact any single segment, be that from the anterior or posterior halves of the worm's body, is capable of regenerating a new head as well as a new tail. And furthermore, as I found, a regenerated tail when severed from the old tissue may also regenerate a new head and thus form a little worm, if kept under favorable conditions. This little worm then is formed entirely of regenerated tissue, but for all the rest so far as anatomical structure is concerned it is identical with the parent organism.

It is to the regeneration in these little worms, themselves formed of regenerated tissue, that I directed my attention.

Two pieces of approximately equal length, one from the anterior half and another from the posterior half of Lumbriculus were left to regenerate for fourteen days. Let us name all these pieces obtained from the front and hind portions of the worm, A and B, respectively. I showed elsewhere that pieces taken from the anterior region of worms regenerate at a higher rate than those taken from more posterior regions. Thus, all the A pieces, regenerated new tails with a rate of 4.4 segments on an average to each one old segment; while the B pieces regenerated on the average 2.6 segments per one old segment. To make this matter clear I will illustrate it by an hypothetical case. Suppose that all the A pieces and all the B pieces were composed of ten old segments each, then the regenerated tails would on the average have consisted of 44 and 26 new segments, respectively.

At the end of fourteen days all the regenerated tails were cut off. A large percentage of these detached regenerated tails regenerated heads, and a new generation of worms, which presented a race of dwarfed Lumbriculi, was thus originated. We will name all these dwarfed worms **a** and **b**, the former being the descendants of the A pieces, and the latter of the B pieces.

After a while these little worms were also subjected to an amputation of their tails, and were left to regenerate for a period of fourteen days. At the end of this fortnightly period it was found that the average number of regenerated segments per one old segment was 0.11 in the **a**-worms, and 0.06 in the **b**-worms.

Measuring the power of regeneration by the average number

of new segments per one old segment, we find that the power of regeneration in the A-mother pieces is greater than that in the B-mother pieces, 1.7 times, which is the ratio between 4.4 and 2.6.

According to the same principle of calculation, the power to regenerate in the little worms, **a**, which are the asexually produced offsprings of the A-mother pieces, will be 1.8 times greater than that in the little worms, **b**., which are the offspring of the B-mother pieces.

Thus we find that tissue regenerated from a part of an animal's body which possesses a high power of regeneration will also have a comparatively high power to regenerate, while tissue regenerated from a part which has a lower capacity to regenerate will also have a low capacity, and furthermore, the ratio between the rates of posterior regeneration in the mother-pieces is very nearly like that between the rates of regeneration in their regenerated offspring.

Such cases may be regarded as genuine hereditary phenomena, since a character, or the power to regenerate in this instance, is transmitted from one individual to another. It differs, however, from other cases of hereditary transmission, in the fact that the new generation is not produced from the fertilized egg by the process of embryological development, but from regenerated tissue. This led me to the conclusion that, "The property of regeneration passes over to the new tissue together with the protoplasmic material it is built of."

State University, Columbus, Ohio, November 26, 1907.

DESCRIPTIONS OF NEW NORTH AMERICAN TABANIDAE.

JAMES S. HINE.

Many of the species described in this paper come from the southern parts of North America where least collecting has been done. After having taken a trip to Guatemala I am satisfied that careful work in that country throughout the season will bring to light many unknown species. The collecting that has been done there has been the result of short trips to various localities, usually by collectors who have been interested in making general collections, so it seems that we have not had the opportunity to get a comprehensive notion of the fauna, at least this is true in reference to the Tabanidae. Among the permanent inhabitants of the country, the study of entomology has not advanced to the stage where it is the practice to preserve specimens in collections, to any marked degree, for the use of students; at least in the museums that I visited only a few of the commoner Tabanids were to be seen. What is true of Gautemala is true, no doubt for other Central American states. It is to be hoped,

therefore, that these more remote localities may be investigated in the near future, and that the collections made be studied with a view to making our knowledge of North American Tabanidae as complete as it appears desirable to make it.

The generic characters in the Tabanidae are not abundant, so the family cannot be divided up as many other families are. For example, the genus Tabanus, as at present restricted, is very large, containing not less than 1,50J species from all parts of the world. Even the large number of species indigenous to the Nearctic region makes it difficult to recognize all of them, especially if the descriptions are poor. There are a number of names placed under the genus that have never been used expect on type specimens, but future collecting will make it possible, no doubt, to more fully establish many of these. I have studied all the descriptions known to me, and now and then have found specimens that do not appear to fit any of them. During several years of collecting and study, therefore, a number of specimens have been set aside as undescribed. Some of these are named at this time in order that it be possible to refer to them definitelv in the future.

Tabanus muscoideus n. sp. Length 9 millimeters. A species nearly the size of our common Sarcophagids and on account of the plainly striped thorax and black and white abdomen resembles these flies very closely.

Female. Front wide and clothed with gray dust but with a black area at the vertex; frontal callosity half as wide as the front, gradually narrowed above and coming to a point half way to vertex. Antenna black, short, first segment small, third wide at base and rapidly narrowed toward the annulate portion which is of nearly the same length as the basal portion. Palpi reddish brown, less than half as long as the proboscis. Thorax black, with very prominent gray stripes, legs black, front coxae very long, nearly two-thirds the length of the femora; wings hyaline, only the anal cell closed. Abdomen black in ground color, first segment with a small white spot behind the scutellum, second segment with a middorsal gray stripe and narrow posterior gray margin, other segments each with a posterior gray margin which is slightly widened at each end and at the middle. The abdomen is distinctly pointed posteriorly, a character which appears to be characteristic of the species.

Females taken at Panzos, Guatemala, March 18, 1905, from the back of a mule which was staked out to pasture.

This is a most peculiar species but, although it has a peculiar appearance, there appear to be no characters which would warrant erecting a genus for it.

Tabanus maculifrons n. sp. Length 8 millimeters. "A dark colored species with hyaline wings and a narrow gray posterior

margin to each abdominal segment. A conspicuous undenuded dark patch or spot on the middle of the front.

Female. Front rather wide, distinctly narrowed below, ground color gray but with a dark colored undenuded patch or spot on the middle of the front and another at vertex; frontal callosity as wide as the front, shining black and connected with an almost obsolete line above. Antennae brownish red, first segment small, third widest at the base and gradually narrowed to the annulate portion, thus there is no distinct tooth above, basal portion longer than the annulate portion; palpi thick at base, pointed below, rather dark colored. Thorax from above with a gray margin which includes most of the scutellum, and a dark colored disk which is furnished with green-reflecting scales or hairs; wings hyaline, stigma yellowish, furcation of the third vein with a short appendage; legs black, bases of the front tibiae and half or more of the basal parts of the middle and hind tibiae yellowish. Abdomen black, each segment with a narrow posterior gray border which expands into a small triangle on the middorsal line.

Females taken near Puerto Barrios, Guatemala, March 4, 1905. They were flying actively and now and then came to rest on weeds and bushes. Fully distinct from all species known to me.

Tabanus limpidipennis n. sp. Length 16 to 18 millimeters. The eyes are pilose but there is no ocelligerous tubercle. The species therefore belongs to Osten Sacken's Atylotus and suggests T. rienwardtii, but differing from that species the wings are entirely hyaline.

Female. Front about three fourths of a millimeter in width, slightly narrowed below, frontal callosity light brown, nearly square, and as wide as the front, a disconnected spot above, nearly half way to the vertex. First antennal segment somewhat produced above, brownish in color and clothed with black hairs; third segment at extreme base brown, otherwise black, cut out above so as to form a distinct but not an extended tooth at base. Palpi thickened, yellowish and clothed with white hair. Thorax in ground color dark, with nearly obsolete gray stripes and clothed with a rather dense coat of elongate white hair; legs reddish brown with the apexes of all the tibiae and entire tarsi black; wings hyaline. Abdomen dark brown above with a middorsal row of gray triangles and a row of rather small rounded gray spots on either side.

Male. Head rather large, eyes with a distinct area of enlarged facets above. Ground color of the abdomen more reddish brown than in the female. In other respects the two sexes are alike.

A male taken at Gaulan, Guatamala, January 21, 1905, and a female taken in Guatemala in 1906.

Tabanus quinquemaculatus n. sp. Length 12 millimeters. A black species with gray striped thorax and a small white triangle on the middorasl line of each of the first five abdominal segments. The general aspect is that of a small specimen of Tabanus coffeatus.

Female. Front of ordinary width, clothed with white dust below and dark dust and black hairs above; frontal callosity shining black; about half as wide as the front and connected with a rather short narrowed extension above; antennae entirely black, first segment enlarged and somewhat produecd at the anterior upper corner, third segment cut out above so that a distinct but not an elongate tooth is formed at the base. Palpi light colored and clothed with black hairs. Thorax black above with rather narrow gray stripes; wings hyaline, although there is a brownish tinge visible over much of the basal half; legs black, basal two thirds of the middle and hind tibiae reddish brown. Abdomen black, posterior margin of each segment narrowly white expanding into a small white triangle in all but the last two. Much of the body, especially the under parts, is clothed with sparse hairs.

Female taken near Morales, Guatemala, March 3, 1905, where it was resting on a freight car.

Tabanus nefarius n. sp. Length 22 millimeters. General color brown, wings brown, margins of the transverse veins and the furcation of the third vein infuscated. Abdomen with a middorsal row of gray triangles, each of which connects with a grayish yellow posterior border of its respective segment.

Front rather narrow, sides parallel, frontal callosity light brown, a little narrower than the front, slightly elongated and connected above with a narrow line, which reaches above the middle of the front. Space just above the antennae and the cheeks clothed with yellow dust, face below the antennae clothed with lighter dust. Antenna light brown with the annulate portion of the third segment darkest; first segment rather long clothed with black hairs which are most conspicuous above, second segment with conspicuous black hairs at apex, third segment elongate with a prominent tooth above, basal portion much longer than the annulate portion; palpi concolorous with the antennae, nearly as long as the proboscis which is black. Thorax with rather indistinct gray stripes, legs of nearly the same color as the body; front femora, apexes of front tibiae and all the tarsi slightly darker than the other parts; wings uniform brownish with infuscated margins to the transverse veins and the furcation of the third vein, first posterior cell closed or nearly closed. Abdomen, in well preserved specimens, brown with a middorsal row of rather small gray triangles and rather wide grayish yellow posterior margin to each segment.

This species is something like T. abdominalis but is larger, the antennae are different in form and there are several other differences. Three female specimens, one taken near New Orleans, July 14, and two taken at Le Compte, Louisiana, August 24, 1906.

Tabanus johnsoni n. sp. Length 20 millimeters. General color of the whole body, including the wings, yellowish brown, front moderately wide with parallel sides. Form somewhat elongate.

Front about three fourths of a millimeter in width, frontal callosity chestnut colored, nearly as wide as the front, upper corners rounded, a narrow line above reaching half way to the vertex, antennae concolorous with the body, first segment clothed with black hairs, second segment with a few black hairs at the apex, third wide at the base, cut out above, thus a distinct tooth is formed, basal portion a little longer than the annulate. Palpi lighter in color than the antennae, proboscis brown, slightly longer than the palpi. Thorax very faintly striped above, legs colored like the body with the tarsi slightly darker; wings yellowish brown with small clouds on the margins of the cross veins and the furcation of the third vein, first posterior cell closed or strongly narrowed. Abdomen yellowish brown with a series of lighter colored middorsal triangles which are so long that each reaches both borders of its respective segment, thus a longitudinal dorsal stripe composed of contiguous triangles is formed.

Females taken at St. Augustine, Florida, by Charles W. Johnson, for whom it is a pleasure to name the species.

Tabanus plenus n. sp. Length 11 to 13 millimeters. A thickset dark colored species with nearly hyaline wings and a distinctly striped thorax.

Front rather narrow and clothed with gold colored dust, frontal callosity brownish, a little more than half as wide as the front below, gradually narrowed above and ending at half the distance to the vertex; antennae very light brown with the exception of the annulate portion of the third segment which is distinctly darker, third antennal segment wide at base with a prominent blunt tooth above, basal portion only slightly longer than the annulate portion; palpi and proboscis brown, the former somewhat lighter in color than the latter. Thorax dark, nearly black in ground color, above with four very prominent gray stripes, the middle two of which reach the scutellum; legs black, stigma of the wings clear brown, wings slightly tinged with brownish which color is very slightly more intense behind the stigma; abdomen dark, nearly black, two basal segments thinly clothed with gray dust, remaining segments each with a fringe of white hairs at the posterior border.

Female specimens taken near Izabal, Guatemala, March 7, 1907, by D. D. Condit.

Tabanus longiusculus n. sp. Length 11 to 13 millimeters. General aspect of T. longus but smaller and darker.

Front or normal width, clothed with gray dust, frontal callosity shining black, nearly square, a separated shining black area above it on the middle of the front; antennae yellowish brown with the annulate portion of the third segment black; third segment not especially wide at base, upper side with an angle near the middle of the length of the basal portion, but there is no process which rightly could be called a tooth; palpi white, thickened; proboscis a little longer than the palpi. Thorax dark with five gray stripes, not very plainly shown; wing hyaline with costal cell dilute yellowish; anterior legs, with the exception of the bases of the tibiae, and bases of middle and posterior femora dark, almost black, remaining parts of legs reddish brown, although the tips of all the tarsi are more or less infuscated. Abdomen with a rather narrow middorsal stripe and a row of rounded spots on either side; therefore each segment is dark in ground color with posterior border, a middle stripe and a spot on either side gray. Venter of the abdomen reddish brown at base and infuscated at the tip.

Female specimens from Southern Pines, N. C., collected by A. H. Manee. Several females from Mimmsville, Georgia, received from C. S. Brimley, agree in detail with North Carolina specimens.

Tabanus minusculus n. sp. Length 10 to 12 millimeters. A rather small dark colored species with the sides of the abdomen reddish brown and the eyes pilose. The wings have a slight brownish tinge, which is caused by a coloring of the margins of the veins.

Female. Front normal in width, frontal callosity as wide as the front, black or dark brown in color, gradually narrowed above and reaching more than half way to the vertex, ocelligerous tubercle present; first and second segments of the antennae brown, third segment brown at the base and black otherwise, distinctly wider than the second at the base and gradually nargrowed to the annulate portion so that no tooth is formed on the upper side although there is a slight prominence in place of a tooth. Palpi long and slender, brown in color. Thorax dark and striped above with narrow gray lines; wings hyaline, veins brown and narrowly margined with a brownish tinge, legs brown, varying toward black in a series of specimens, tarsi more or less infuscated. The abdomen above with a wide black stripe in the middle, interrupted by the narrow posterior margins of the segments, each of which expands into a small triangle on the middorsal line; sides brown, but in a series of specimens there is

variation so that the brown of each side may be reduced to a row of rounded spots. Venter of the abdomen reddish brown at the base and infuscated toward the apex.

Male. Eyes distinctly pilose, no evident separation into different sized facets. Easily associated with the other sex.

Several specimens from Orono, Maine, collected in July, 1899, by the late Professor F. L. Harvey. Other specimens from Oswego, N. Y.; Springfield, Mass., collected by Dr. George Dimmock; and one from Canada.

Tabanus albocirculus n. sp. Length 17 millimeters. Nearly black with fumose wings, narrow front and a black spot surrounded by white on the scutellum. Furcation of the third vein with a long appendage.

Front narrow, with a raised line which reaches from the location of the frontal collosity at least two thirds of the distance to the vertex. Antenna elongate, first segment slightly enlarged, third with a prominent angle at base above, annulate portion not much more than half as long as the basal; palpi light colored and clothed with black hairs. Thorax dark brown, nearly black, scutellum with a round black spot which is margined with white; wings uniformly fumose, furcation of the third vein with a long appendage, first posterior cell slightly narrowed at the apex; legs dark brown, almost black, base of each front tibia white and the entire legs thinly clothed with white hair. Abdomen almost entirely black, but each segment with a gray posterior border which on each of the second, third, fourth and fifth is expanded into a gray triangle at the middle of the dorsum.

Female from Tucurrique, Costa Rica, collected by Schild and Burgdorf. The species suggests Tabanus melanocerus, but the narrow front and conspicuous black spot on the scutellum at once distinguish it.

Tabanus littoreus n. sp. Length 9 to 11 millimeters. About the size of Tabanus pumilus and something like that species in general appearance, front very wide, with a shining black frontal callosity which has no denuded line of spot above it. General color chocolate brown, or a little lighter, the ground color of the thorax being partially obscured by a sparce coating of gray hairs.

Female. Front wide, in the largest specimens nearly a millimeter, scarcely narrowed before, frontal callosity as wide as the front, nearly square, shining black, with no denuded line or spot above; antenna light brown, annulate protion of third segment darker, first segment short and slender, third with no well defined angle above but widest near the base and gradually narrowed, with no evident curve toward the apex; palpi pale, thick at base, pointed at the apex and all but as long as the proboscis. Thorax brown, sparsely clothed with gray hairs; wings hyaline, stigma distinct, brown, first posterior cell wide open, furcation

of the third vein with a long appendage; legs brown, apexes of the front tibiae and the tarsi of all the legs, especially beyond the metatarsi, darker. Abdomen brown, a middorsal stripe and an irregular spot on each side of each segment gray, but these gray markings are not well defined nor conspicuous, narrow posterior border of each segment gray.

Male. Head large, line of separation between the large and small facets well defined, otherwise this sex is like the female.

Specimens of both sexes taken at Puerto Barrios, Guatemala, from twigs and branches of mangrove, growing just at the edge of the water. Nearly related to T. cribellum but differing from it in color and in having a wider front.

Tabanus texanus n. sp. Length 12 to 14 millimeters. A species much like T. costalis in appearance. Eye with a single purple band; thorax with stripes not very plainly marked; costal cell of the wing plainly infuscated; abdomen with three series of yellowish triangles.

Female. Antenna yellow with the annulate portion of the third segment black; first segment slender, third with a distinct angle near the middle of the upper side of the basal portion; palpi yellowish, thick at the base, narrowed toward the tip and nearly as long as the proboscis. Front rather wide with parallel sides; face and front clothed with yellow dust; frontal callosity nearly as wide as the front, square, shining black and with an unconnected spot above. Thorax grayish yellow above and with evident stripes. Wing hyaline, costal cell distinctly infuscated. Front coxa yellow, except at apex, other coxae and all the femora brown; basal half of the front tibiae and all the other tibiae except the apexes yellow; tarsi brownish. Abdomen with three series of yellow triangles separated by drak brown areas. The triangle at the middle of each segment has its base on the posterior margin of its segment and also reaches the anterior border where it connects with the triangle which precedes; the lateral triangular spots have an oblique appearance and plainly reach the whole length of their respective segments.

Male. Head rather large; eyes plainly divided into areas of large and small facets. Color as in the female.

A mlae and female taken at Galveston, Texas, in May, by Dr. F. H. Snow.

Chrysops separatus n. sp. Length 8 millimeters. Body black, wing with costal margin, crossband and apical spot black, apical spot entirely separated from the crossband.

Female. Antenna elongate, first segment reddish brown at base, black at apex, second and third black, third longer than the other two combined. Cheeks, middle of the face, region around the antennae and the sides of the front clothed with a yellow dust. Facial and frontal callosities and vertex shining black. Thorax

black, legs black, wings with costal and first basal cells, crossband and apical spot black, otherwise hyaline. The crossband hardly reaches the posterior margin but comes nearest to it in the fourth posterior cell; the apical spot fills out nearly half of the second submarginal cell and is entirely separated from the crossband. Abdomen entirely black above and below.

Female from Raleigh, North Carolina, collected by C. S. Brimley, April 18, 1906. Entirely distinct from the species of Nearctic Chyrsops known to me.

Chrysops dorsovittatus n. sp. Length 7 millimeters. Ground color of the face black, undenuded parts covered with yellow dust, apical spot of the wing narrowly separated from the crossband. Abdomen with a wide middorsal black stripe, and black apex.

Female Facial and frontal callosities and vertex shining black, cheeks, middle of the face, region surrounding the antennae and middle and sides of the front covered with golden yellow dust; palpi and proboscis black; first segment of the antenna yellowish, slender and slightly longer than the second; second and third segments more or less infuscated, third as long as the other two Thorax black, striped with bright yellow, wing with costal and first basal cells, crossband and apical spot black, apical spot very narrowly separated from the crossband which reaches the posterior border, filling out the fourth posterior call. Legs largely black, anterior coxae, bases of anterior and middle tibiae and all the metatarsi yellow. Abdomen above with the sides of the first segment yellow; wide dorsal stripe and apex black; a narrow extension of the apical black projects forward outside of a yellow space, on each side, to the posterior margin of the second segment.

Male. Colored like the female except that the fifth vein of the wing is widely margined with black, which at the base of the second basal cell occupies the entire width of this cell.

A female from Georgia and a male from Florida. The species is entirely distinct from other Nearctic species of Chrysops known to me.

Chrysops shermani n. sp. Length 9 to 10 millimeters. Thorax black with bright yellow stripes. Black coloring of the wings somewhat broken up by lighter areas along the margins of the veins. Crossband not reaching the posterior margin of the wing.

Female. Facial and frontal callosities shining yellow, the latter margined with black above, region around the ocelli black; palpi yellow, half as long as the proboscis which is black. Thorax black with bright yellow stripes, wing with costal margin, corssband and apical spot black or dark brown; the coloring of the costal and first basal cells is not intense, stigma dark and a few small areas beneath it darker than the other parts. To

the unaided eye the apical spot appears to be separated from the crossband, but a lense shows that shaded bands reach across in the marginal and first submarginal cells. The crossband is much abbreviated posteriorly and is broken up into darkened patches in the region of the discal and second and third posterior cells. Throughout the crossband the vein margins are either hyaline or only shaded with brown. Front legs yellow to middle of tibiae from thence black, middle legs yellow, hind legs yellow, with the exception of the bases of the femora which are black. Middle and hind tarsal segments infuscated apically. Abdomen above largely yellow; first segment with a square black spot at middle, second at middle with a wide stripe furcate behind, and a small spot on either side near the hind margin black; third and fourth segments each with four black stripes which do not quite reach the posterior margins; remaining segments black with yellow posterior margins.

A number of females received from Franklin Sherman, Jr., and collected at Highlands, North Carolina. Also a female collected by E. B. Williamson at Hayden, Ontario, July 10, 1906. Two females taken at Highlands, North Carolina, were sent in by C. S. Brimley.

A note from Professor Sherman is of interest in this connection. He stated at the time he sent the specimens that "they appear to be different from anything we have taken in the state. I have taken the species two different years in the same general region in our mountains at an elevation of about 3,000 feet, and although both times I collected them while driving along a road, they were not to be taken, on the same road the same day, when we descended to 2,500 feet or lower."

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TABLE OF CONTENTS.

AN ESKER GROUP SOUTH OF DAYTON, OHIO.[1]

EARL R. SCHEFFEL

Contents.

Introduction. This paper has for its object the discussion of an esker group[2] south of Dayton, Ohio;[3] which group constitutes a part of the first or outer moraine of the Miami Lobe of the Late Wisconsin ice where it forms the east bluff of the Great Miami River south of Dayton.[4]

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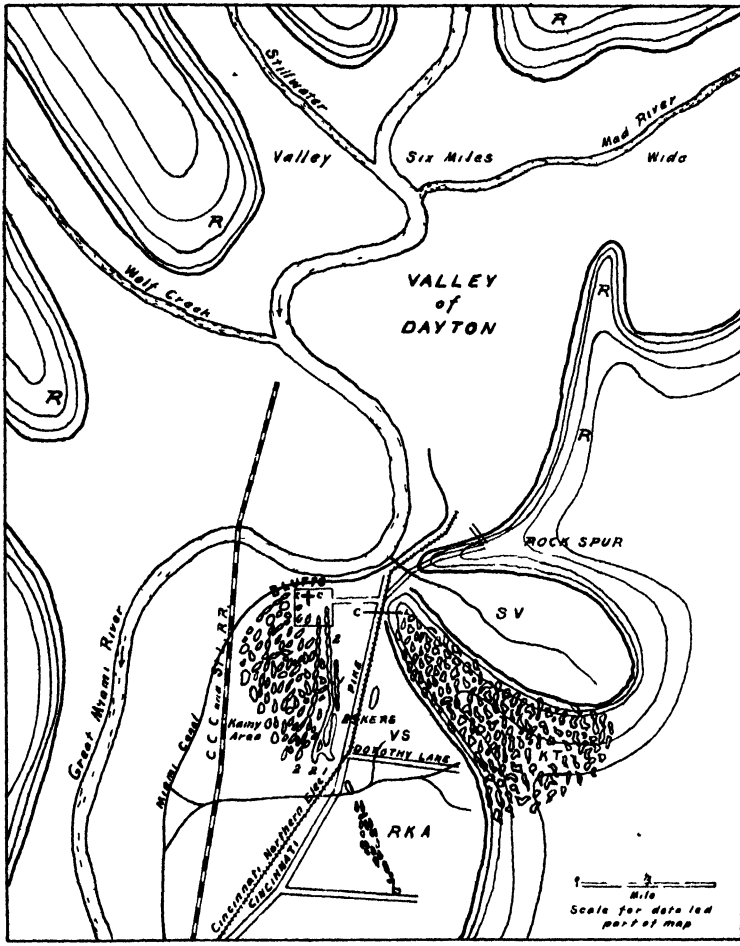
1. Given before the Ohio Academy of Science, Nov. 30, 1907, at Oxford, O., representing work performed under the direction of Professor Frank Carney as partial requirement for the Master's Degree.
2. F. G Clapp, Jour. of Geol., Vol XII, (1904), pp. 203 210.
3. The writer's attention was first called to the group the past year under the name "Morainic Ridges," by Professor W. B Worthner, of Steele High School, located in the city mentioned. Professor Werthner stated that Professor August F. Foerste of the same school and himself had spent some time together in the study of this region, but that the field was still clear for investigation and publication. Professor Foerste later made practically the same statement. The writer is indebted to both of these gentlemen for their courtesy. He also wishes to thank his instructor Professor Carney, for going over the field with him and taking the several excellent photographs illustrating this article.
4. F. Leverett, Monograph XLI, U. S. Geol. Surv., (1902), p. 355.
T. C. Chamberlin, 3rd Annual Report, U. S. Geol. Surv., (1881-82), p. 334.



GREAT MIAMI VALLEY
FIG. 1

This figure shows in the lower part a map of the esker and kame region. The topographic features are drawn purely diagrammatic, being intended only to give a general view of the relationship of the valleys, esker and kame area to the valley walls.

Representations of Initial Letters: R—Rock (outcrops); S. V.—Small Valley; V. S.—Valley Segment; K. T.—Kamy Topography; R. K. A.—Ridged Kame Area; 1, 2—Eskers Nos. 1, 2; 1′, 2′—Knoll Endings of Eskers; C. C.—Calvary Cemetery; C. L.—Southern Corporation Line of City of Dayton.

General Discussion of Eskers. Much question and dispute has arisen in the past concerning the terminology[5] for certain ridge-like products of glaciation, but the designation "Esker" is generally applied by American Geologists to lines of debris presumably aggraded by streams between walls of ice. Though the theory of deposition in sub-glacial tunnels[6] holds the greatest credence today, the en-glacial and super-glacial or various combinations of the three theories have been offered as plausible explanations in specific instance.[7] For convenience this article assumes in the beginning that the Dayton ridges are eskers, and that they were formed in sub-glacial tunnels.

Preliminary Description of Region. (Fig. 1.) The northern end is known locally as "The Bluffs." These trend east-northeast to west-southwest about half a mile presenting an abrupt slope considerably over one hundred feet high toward the valley of Dayton to the north. The Miami canal runs along the slope not far from its bottom, and below this at the base of the Bluffs flows the Great Miami River. The topography of this and also of the western half of the area presents a beautiful study in kames; mounds and basins[8] are abundant. The mounds or knolls frequently show a tendency toward alignment producing ridges. The eskers indicated on the map constitute the eastern boundary of this kame area. They overlie their base like railway embankments crossing uneven topography.[9] From the region of the Bluffs they proceed southward about a mile ending bluntly on the Miami Valley. The crest-lines are sinuous in both vertical and horizontal directions, though the general course is in almost a straight line. The esker form is at times modified by knolls, rarely by distinct gaps. The crests are narrow and the sloping sides steep, apparently taking the angle of repose normal to the debris of which they are composed. Both the eskers and the kamy topography westward rest upon a base rising above the valley of the Miami. To the southeast, across the roadway from the southern ends of the eskers the kamy topography continues for about a mile. This topography shows a curious branching and anastomosing of ridges. Though at present suggestive of kames it is quite possible that it represents modified glacial phenomena of other than kame origin. A more elaborate study of this will be made in a future paper.

5. G. F Wright, The Ice Age in North America, (1891), p. 296.
G. H. Stone, Monograph XXXIV, U. S. Geol. Surv., (1899), pp. 35, 359.
W. C. Morse, The Ohio Naturalist, Vol. VII, (1907), pp. 63–65.
6. Chamberlin & Salisbury, Geology, (1906), Vol. III, pp. 373–7.
7. W. M. Davis, Proc. Bos. Soc. Nat. Hist., Vol. XXV, (1892), pp. 477–99.
J. B. Woodworth, Proc. Bos. Soc. Nat. Hist., Vol. XXVI, (1894), pp. 197–220.
O. H. Hershey, Am. Geol., Vol. XIX, (1897), pp. 197–200 237–253
W. O. Crosby, Am. Geol., Vol. XXX, (1902), pp. 1–39.
8. T. C. Chamberlin, loc. cit., p. 334.
9. Chamberlin & Salisbury, loc. cit., p. 375.

Bearing on Archaeology. There has been a tendency in the past to explain formations of the esker type as the work of Indians or Mound Builders,[10] an error not without justification. Evidence of design in the Dayton ridges is patent to the unitiated. They suggest an immense fortification composed of lines of earthworks; the knolls serving as lookout and signal stations, gaps for ingress and egress, and short connecting embankments as roadways from ridge to ridge. Several references are made in local histories[11] to the work of Mound Builders found in what is now Calvary Cemetery (C. C., Fig. 1). Of these the following quotation is the most comprehensive:—"South of Dayton on a hill one hundred and sixty feet high is a fort enclosing twenty-four acres. The gateway on the south is covered in the interior by a ditch twenty feet wide and seven hundred feet long. On the northern line of embankment is a small mound from the top of which a full view of the country for a long distance up and down the river may be obtained."[12] Other isolated portions are explained similarly by residents.

Such explanations are to be doubted as few if any more than the number of Indian relics normal to this section of Ohio are found. Even admitting the archaeologic suppositions, the accredited Indian work constitutes so little of the region studied, with but trifling interference to the general plan, that it may be disregarded. That no large portion can be of human construction is apparent not alone from the size of the formation, but from the evidence of assorted material in numerous cuts.

Topographic Relations. Eskers differ in their relations to the topography of the area on which they rest, but according to Chamberlin and Salisbury they were probably most frequently made by streams flowing about "parallel to the direction of the ice movement."[13] The same writers also suppose the most favorable position for their formation to be "near the edge of the ice during the time of its maximum extension or retreat."[14]

It is possible that the topography of the Dayton area offers the best explanation, on a sub-glacial hypothesis, for the origin of these local eskers. Dayton lies in a large valley (Fig. 1) formed by the junction of the Stillwater and Mad Rivers and Wolf Creek with the Great Miami River. The enclosing rock-bearing hills rise about 200 feet above the flood plain. The basin is filled with a varying depth of debris exceeding in places 200 feet.[15] The maximum width of the valley is about six miles. To the southward beyond the junctions the valley narrows to about

10. G. H. Stone, loc. cit., p. 35.
11. History of Montgomery County, Ohio, (1882), p. 216.
12. Quotation in "History of Dayton," (1889), p. 10, from J. P. McLean's work, "The Mound Builders."
13. loc. cit., p. 376.
14. Ibid, p. 374.
15. F. Leverett, loc. cit., p. 361.

one-third its greatest width. This narrowing is produced principally from the eastern side by a rock spur (Fig. 1), south of which the valley again widens but not to its former size. The last rock outcrop on this spur was found on its top and several hundred yards from the end. The Bluffs extend west-southwest from this spur, the two prominences being separated by a gap which permits the egress of drainage from a small valley (S. V., Fig. 1) connected with the spur. The eskers and kame area spreading southward from the Bluffs cut off a small segment of the Great Miami Valley (V. S., Fig. 1) lying south of the spur.

Theories of Origin. In diagrammatic view (Fig. 1) the valley of Dayton appears as an oblong basin with wide gaps for the entrance of the Miami River and tributaries, and one for the departure of the combined drainage. This great basin may have exerted an important influence on the waning glacial ice in controlling its movement in this area, and also in concentrating drainage that became sub-glacial.[16] That this basin and its tributaries do represent glacial drainage lines[17] is proved by the great depth and character of the debris filling. The over-riding ice would drop into the Dayton valley as in a pocket. This in the stagnant ice stages would accentuate its immobility thereby conducing to esker-forming conditions. The concentrated drainage would seek the point of easiest egress which would probably be somewhere in the gap to the south. While under great head, as doubtless the drainage would be at times of most active ice-melting, topography might to some extent be disregarded. This could explain the appearance of the ridges on the eastern side of the valley gap (possibly even superimposed over a continuation of the rock spur) rather than in the center.[18]

The close association of the eskers with kame deposits suggests that the latter were formed during the retreat of the ice after the eskers had been built in sub-glacial stream tunnels. This kame area doubtless spread originally further across the valley but has in part been removed by the meanderings of the Miami River. The abrupt face presented to the north by the Bluffs may also have the same explanation; it has already been noted that this river flows at the present time along their base. If this explanation is correct, the kame and esker topography may formerly have extended an indefinite distance northward into the Dayton Valley.

Detailed Description of Eskers. It is unsafe to number these ridges as marking separate and distinct lines of drainage, but for convenience this method will be adopted. The easternmost will

16. I. C. Russell, Jour. of Geol. Vol. III, (1895), p. 827.
O. H. Hershey, loc. cit., p. 240.
17. F. Leverett, loc. cit., Pl. II.
18. Chamberlin & Salisbury, loc. cit., p. 375.

be designated No. 1 and the next west No. 2. Other lines may exist buried beneath and masked by the kame deposits.

No. 1 (Figs. 1, 2.) This may branch from No. 2. As an independent ridge it proceeds from its head (about a quarter of a mile below Calvary Cemetery) southward and almost parallel with the Cincinnati Pike to a point almost opposite Dorothy Lane (Fig. 1) where it ends in a cut. The upper end of this esker though distinctly ridged is not as typically esker-like as the lower end. Intersections between No. 1 and No. 2 occur near their southern terminals. These intersections at one point form a "Y", the base of which starts from No. 1, the branches leading to No. 2. At all the intersections, four in number, the ridges

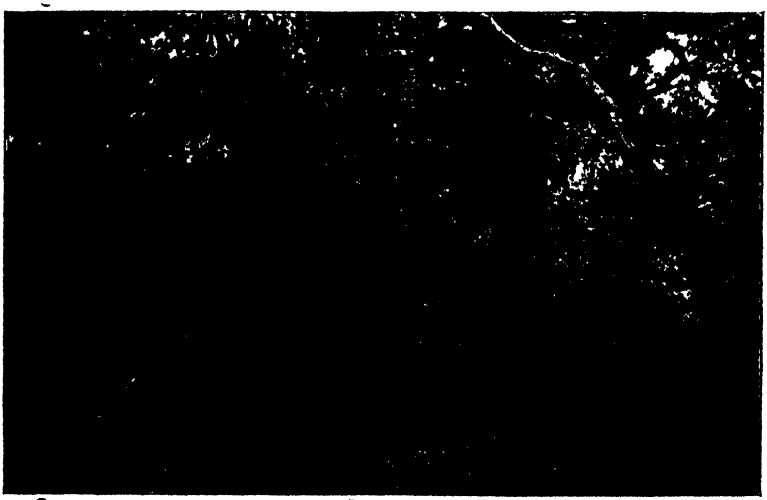


Fig 2. View looking north on esker No. 1.

rise, forming knoll-like prominences. Small boulders about the size of cobbles are abundant on the surface. These are largely of local limestone of the same formation (Cincinnati) as that seen in the rock spur before mentioned. The exposed cut at the road shows principally coarse gravel mingled with sand. Some of this gravel has been cemented together into a form of conglomerate by the action of carbonated water.[19] Several feet of till containing a large percentage of small boulders overlies the gravel at this point. This exposed section at the time of the writer's first visit revealed the anticlinal stratification frequently mentioned in offering sub-glacial theories of origin. This may possibly be explained, however, by slumping of the material after

19. E. Orton, Geol. Surv., of O., (1869), p. 146.

the withdrawal of the ice. This cut has been extensively used by the Cincinnati Northern Electric, which runs alongside, in securing ballast for its new roadway.

No. 2. (Figs. 1, 3, 4.) This starts just within Calvary Cemetery. A short longitudinal cut has been made on the west side of this end, furnishing the gravel supply for the cemetery. From an abrupt rise it proceeds southward, coming alongside of No. 1, and following almost parallel. To the south it branches and ends bluntly on the Miami Valley in two prominent knolls aligned with the cut of No. 1 (Figs. 1, 6). Water is imponded at several points between No. 1 and No. 2. This ridge is separated the greater part of its length from the kamy area to the west by a distinct and deep trough.

Fig. 3 (*F. Carney*). View looking north on esker No. 2. A sharp turn and steep rise shows in background.

Kamy Area to the West of Eskers (Figs. 1, 5.) The kames here show a tendency toward alignment in short ridges. Sometimes they appear to radiate from a common center. Artificial cuts facing the valley show prevailingly fine material indicating by the stratification a very active play of waters.

Studies.

Proximity of Eskers. The distance between the two eskers is always slight. The surface outline of this distance is usually similar to a parabola shaped trough of such a size that if one of the adjoining ridges were inverted it would approximately fit the trough. The drainage from the troughs is principally through the soil.

Height of Eskers. The variation in altitude of the crest-lines and of the troughs gives varying heights at different points. No. 2 by aneroid measurement varies from 35— to 95+ feet in height. No. 1, if measured, doubtless would give similar results.

Reticulation. The two eskers show several connecting branches. This implies a union between the lines of drainage some time during their existence. These connecting branches are so depressed in parts that tracing is difficult. Such a condition would be natural as the cross drainage would normally be so sluggish that the tunnel carrying it would probably never attain a large size. It is a question whether the two eskers represent branches from one line of drainage or are entirely independent. They may even represent a shifting of drainage lines. The lower end of No. 1 suggests by its position (Fig. 1) that it may be a branch from No. 2, rather than a continuation from the head end of No. 1, as we have described it.

Fig. 4 (*F. Carney*). Camera reversed from fig. 3, and view taken looking south on same esker.

Knolls. Hummocks are frequent. Generally they mark the southern termini and ridge junctions. At its head end No. 2 is composed of a series of four joined together. Many theories[20] are given for the origin of such swellings. In connection with knolls other modifications of the esker type may be noted. Several buttress-like deposits were found lying against the bases of the eskers; sometimes also a fan-like spreading of debris from a similar position was observed. These irregularities probably mark the entrance to the major line of small tributary streams, or as an alternative, the opposite condition, leakage from the major lines. The knolls at the head of No. 2 are more suggestive of tributaries than of kames.

The knoll-endings (Figs. 1, 6) on the Miami Valley suggest by their alignment that they have been cut off at this point by the Miami River. Though this stream here turns to the westward, the even floor of the valley is evidence that it formerly turned

20. J. B. Woodworth, loc. cit, pp. 202, 203.

eastward. The fanning of the knoll-endings into the valley where they meet in an even slope is doubtless the result of slumping. Davis[21] gives a clear exposition of conditions when bodies of water are dammed by the ice-front, with the consequent phenomena of sand plains built up by esker streams. The Dayton area, however, shows no evidence of favorable conditions for the holding of ice-front waters, drainage having a perfectly free course toward the south. Streams emerging from the ice would spread out and quickly drain away. In this particular area such an outwash plain if formed would have been destroyed long ago by the erratic wanderings of the Miami.

Fig. 5 (*F. Carney*) Kame area immediatbly west of esker No. 2. Camera facing north. Barn rests on a long ridge of kames.

Altitude of These Deposits. The elevation of the area above the valley is partly due to the base upon which it rests. This is shown particularly in the kame region, the inside slopes of which are much shorter than the slopes facing the valley, a condition explainable by slumping within the area and erosion around it by the Miami as before stated.

In this connection it may be suggested that possibly gradation has greatly modified the original eskers. At the time of ice-withdrawal these forms, particularly if sub-glacial in genesis, must have been left with little or no vegetative protection. It cannot be determined how long a time was required before plant life secured a good foot-hold, but it is reasonable to suppose that the interval was sufficient to permit considerable weathering even on such narrow forms as eskers. With the eskers in question is it not probable that after the constituting material had assumed its natural angle of repose they may have been considerably lowered by gradational processes? Such processes would also reduce the effect of height by partially filling the trough. . .

21. W. M. Davis, Bull. Geol. Soc. Am., Vol. I, (1890), pp. 195-203.

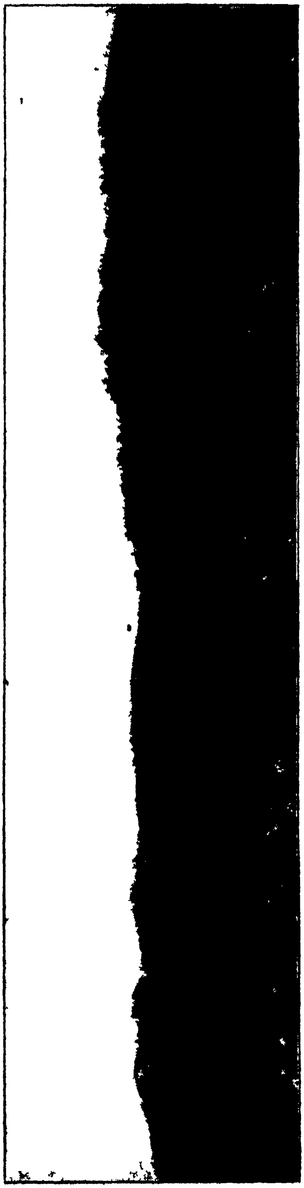


Fig. 6 (*F. Carney*). View looking north from Miami Valley, showing southern termini of eskers Knoll to right belongs to esker No. 1. Two knolls next west apparently belong to esker No 2. Westernmost knoll is a part of the kame area.

Composition of Eskers. A layer of bouldery till spreads over the group. This varies in thickness sometimes being five or six feet deep. Such a deposit, of course, supports the theory of sub-glacial origin, representing as it does the melting of a body of debris-laden ice above. The gravel beneath this till in the eskers is composed of a large percentage of Ohio limestone intermingled with foreign rock. Though mixed with sand it is practically free from clayey material. Cobbles of flat angular limestone are abundant on the surface. At times these cobbles intermingled with foreign boulders of similar size literally pave the surface, a result possibly of concentration through the removal of fine material by washing. Big granite boulders are rare.

Rock Weathering. The surface boulders show varying degrees of weathering. The limestone, not being very resistant to water action, particularly shows age. Granites sometimes appear fresh at other times are decidedly pitted. If this irregularity is not due to their chemical composition, the inference would be that boulders representing several different glacial periods have been mingled. In a stream-cut south of the eskers many greenstones appear. These are described by Chamberlin and Salisbury[22] as particularly abundant in sub-Aftonian drift. It may be that in these conditions evidence may be found that this area represents pre-Wisconsin glaciation and later reworking during the Wisconsin period. Such a theory would not necessarily oppose anything that has already been conjectured with regard to the history of the region.

Crest-Lines. While the crest-lines are sometimes quite hummocky, the typical esker form is found in all its beauty. Straight, even-sloped sections several rods in length may be found, but the course usually is serpentine, the crest-line waving up and down and from one side to the other of a straight line. Several gaps occur, some perhaps artificial; others may be due to constrictions in the ice tunnel or various local modifying conditions. Though the general course of these eskers is straighter than in the usual type, this offers nothing inconsistent with the sub-glacial theory of origin; in fact it seems reasonable to suppose that confined streams of sufficient size to build up immense ridges of coarse material would naturally hold to a comparatively straight course.

Economic Importance.

These ridges have great economic value. The supply of gravel and sand is practically inexhaustible. The C. C. C. & St. L. steam R. R., and the Cincinnati Northern Electric run conveniently near and have made extensive cuts in securing ballast. The position of the ridges overlying the valley reduces the ex-

22. loc. cit., p. 384.

pense of cutting to a minimum. Tracks are run alongside and big steam scoops gather up the gravel and throw it into cars. In addition to that used by the railroads many loads are taken away in wagons. Formerly considerable sand and gravel was taken from the Bluffs by boats plying on the canal; this method of transportation is no longer operative, partly because of the decreased depth of this waterway. The group occupies something less than a square mile of surface. But little of this acreage is devoted to farming, most of it serving for pasture. There are several very desirable locations for summer homes and also opportunities for parking.

Area to the East.

The easternmost esker and the ridged relief starting on the opposite side of the roadway at its southern end block off a portion of the valley apparently belonging at one time to the Great Miami, though the level of this valley is considerably higher than the present flood plain of the Miami Valley

Conclusion and Summary.

Eskers of Ohio have not been studied so exhaustively as those of other parts of the country, particularly of New England. Leverett, however, mentions eleven in this state, according to the tabulation by Morse[23] in his article on the "Columbus Esker."

In describing this area and in drawing inferences the writer has endeavored to be exact and not dogmatic. Some slight errors may have been made in data; theories in any case are uncertain. It may not be possible to work out with assurance the history of the group. So many factors may have operated together or against each other that the result would appear to be without "rhyme or reason" and too complicated for unraveling. From the present day evidence, however, the following conclusions are reached with some confidence:

1. These eskers conform in details to the type generally conceded to be of sub-glacial origin.
2. Their location was largely dependent on topography, lying as they do in a position favoring active sub-glacial drainage.
3. The heavy stratified glacial deposits other than eskers also indicate an activity of drainage beneath the ice or from its front.
4. The varying texture of the boulders suggests a reworking of old glacial debris by the last ice-sheet.
5. The inexhaustible supply of gravel and sand offered, together with convenient location and easy access give the area considerable economic value.

23. loc. cit., p. 66.

NOTES ON THE APHIDIDAE. (I.)

Observations on a Semi-aquatic Aphid, *Aphis aquaticus* n. sp.

C. F JACKSON.

This species is a typical representative of the genus Aphis, and may be characterized as follows:

Winged viviparous female. Head broad, sparsely covered with hairs, two prominent hairs just above the median ocellus. Eyes black, prominent, the two lateral ocelli in proximity to the two compound eyes; ocular tubercle large. Antennae reaching slightly beyond thorax, joint I and II short, III nearly equal to IV and V taken together, slightly imbricated, the posterior margin bearing fifteen or more sensories. Joint IV slightly longer than V bearing three sensories and imbricated; V closely imbricated with two or three sensories near distal end; joint VI (including unguis or VII) longer than IV and V taken together; the unguis very long and slender, at the base of which is a group of six or seven sensories. Total length of antennae 1.6 mm.; length of I, 0.08 mm.; II, 0.08 mm.; III, 0.39 mm ; IV, 0.27 mm.; V, 0.23 mm.; VI, 0.14 mm.; VII, 0.46 mm. Beak stout, reaching third pair of coxae. Thorax well developed, the pro-thorax bearing a distinct lateral tubercle. Each thoracic segment has on the ventral side a pair of small wax glands. Wings long and narrow, with veins extending nearly to margin, the second branch of the cubital not occuring until near the end of that vein. Length of fore wing 3.1 mm.; width 1.1 mm.; length of hind wing 1.3 mm., width 0.5 mm. Legs long, slender, tibia provided with four more or less regular rows of long hairs. Femur and tibia covered with a fine pulverulence. Abdomen ovate, the second and eighth abdominal segments with distinct lateral tubercles above which is found a long bristle like hair. Honey-tubes 0.35 mm. long, nearly cylindrical or slightly vase-shaped. Cauda conical, provided with two pairs of long recurved hairs; outer margin serrated. Length 0.12 mm. Anal plate provided with six or eight pairs of long, curved hairs; outer margin of plate serrated. Color very variable, abdomen dark green, thorax lighter tinged with yellowish. Poorly fed individuals may be very light, while old specimens may be found of an almost uniform black color. Total length of body 1.95 mm. Wing expanse, 7 mm. Immature resembling adult except that the thoracic tubercle, wax glands and abdominal tubercles are much more prominent, while the cauda does not appear until the third molt.

Apterous viviparous female Head sparsely covered with hairs, eyes black, prominent. Antennae reaching nearly to the honey-tubes; joints I and II short, III but slightly longer than

IV which is imbricated, both being without sensories; V nearly as long as IV with one sensory near distal end; VI (including unguis) nearly as long as III, IV and V taken together, deeply imbricated. At the base of the unguis is a group of six or seven sensories as in the winged form. Total length of antennae 1.15 mm.; length of I, 0.06 mm.; II, 0.07 mm.; III, 0.22 mm ; IV, 0.18 mm.; V, 0.16 mm.; VI, 0.10 mm.; VII, 0.38 mm. Beak stout reaching third coxa. Thorax narrow, the pro-thorax bearing a lateral tubercle. On the sides of the thorax below the tubercle are three pairs of very distinct wax glands secreting a white flocculent material which covers the side and ventral portion of the thorax. Legs long and slender; tibia provided with four more or less regular rows of long hairs. Legs with the exception of the tarsus covered with a fine pulverulence. Abdomen large and swollen, the second and eighth abdominal segments with distinct lateral tubercles and bristles which project out above them. Honey-tubes slightly vase-shaped, 0.35 mm. long. Cauda 0.10 mm. long, which with the anal plate resemble the same structures in the winged form. Color, dark brownish or greenish black, but becoming a clear green under poor food conditions. Frequently forms will be found with three longitudinal black stripes down the abdomen. Older specimens may be nearly jet black in color. Total length of body, 2.10 mm.; width of abdomen 1.15 mm. Immature resembling adult but frequently lighter in color.

The circumstances which led to a special study of this form are as follows:

During the latter part of last September a number of aquaria at Ohio State University were partially filled with sediment and water plants of various kinds and set aside to wait the development of Protozoa and Hydra for class use. One large aquarium containing *Philotria canadensis* was placed just outside the window where it remained for some time until a thick growth of the *Philotria* developed, the tips of which projected slightly above the surface of the water.

On October 14 the aquarium was brought into the laboratory and great was my surprise to find the surface of the water and tips of the projecting *Philotria* covered with small black aphids which were apparently as much at home on the water as any other place. A careful search was made for a winged form which might have started the colony but none could be discovered. The only individuals present were dark brownish-black apterous females. At first I was led to believe that the presence of aphids on so strictly an aquatic plant as *Philotria* was purely accidental and that some chance migrant from an annual plant had fallen into the aquarium and having the ability to adapt itself to the new food plant at once began to reproduce. The off-spring

having nothing else to live on were forced to follow the example of the parent. However, after a detailed study of the adaptations of the insect to its semi-aquatic life I am convinced that it is a true semi-aquatic insect though not necessarily confined to *Philotria* but may feed on other aquatic plants. The colony was probably started by a winged migrant or by wingless forms brought in with *Philotria* or some other water plant.

The latter conclusion was strengthened by Mr. H. H. Severin, who reports that a similar aphid was very troublesome on aquatic plants in the green house at Wisconsin State University. Professor F. L. Landacre also says he has noted probably the same insect on various aquatic plants at Columbus several years ago. While doing some field work in Sandusky Bay a few years ago I noticed large colonies of aphids frequenting the lotus buds, but at present cannot say as to the identity of the two species.

One peculiarity which attracted my attention was the ease with which the aphids walked over the surface of the water, or were found half submerged in an attempt to feed on aquatic plants. An accurate examination of the forms showed that on either side of the thorax were located three pairs of wax glands. These glands resemble in all respects the thoracic or abdominal wax glands found in many other aphididae, but in every instance with which I am familiar the thoracic glands occur near a median dorsal line. Another fact which brings out this remarkable condition more forcibly is the relation of a small thoracic tubercle to the wax glands. In a great number of aphids a tubercle projects out from the sides of the thorax, but always below the wax glands when these are present. In this insect the glands lie below the tubercle and consequently on the ventral-lateral side. It is quite clear that this waxy secretion would be of the greatest value in keeping the insect from getting wet, as it not only projects out from the body, but is also powdered over the entire ventral portion of the thorax. While walking on the water this secretion is always in contact with the surface and serves as a float while the insect pushes itself along, moving quite as rapidly as on a dry surface.

In addition to this protection from the water the legs are covered with a fine pulverulence. This characteristic however is not at all peculiar to this species but is found on many other insects. On the sides of the seventh and eighth abdominal segments may always be found two tubercles directly above which small hair-like bristles project. These structures may be of value in determining the species. The number of sensories on the third joint of the antennae seem to be very inconstant, ranging from fourteen to eighteen. However, at the base of the unguis there is a fairly constant group of six or seven sensories both in the winged and wingless forms The color cannot be relied upon as will be shown

later. In summing up the specific characters the three thoracic wax glands below the lateral tubercle, the two abdominal tubercles with their accompanying hairs, and the group of six or seven sensories at the base of the unguis ought to determine the species for the winged or wingless form.

A great deal of speculation has always existed as to the function of the honey-tubes. Repeatedly while observing the insect I noticed the honey-dew given off from the anal opening. A small drop of clear liquid would be extruded, and by means of the left foot the liquid would be thrown one or two inches. Therefore, in this particular instance I am quite certain the honey-dew is not extruded through the tubes. The honey-tubes always contain two structures. Running the entire length is a fine tube very much resembling a trachea. This could only be seen in freshly mounted specimens and could not be traced into the body of the insect. In addition to this the cavity of the honey-tube always contains a number of characteristic bodies, oval in shape, with clear centers. These bodies break down in certain mounting media and frequently form crystals. Since it is quite uncertain whether or not malphigian tubules exist, it is possible these bodies are the result of an excretory process. Both tubes and bodies have been observed by other workers, but I think as yet have not been explained.

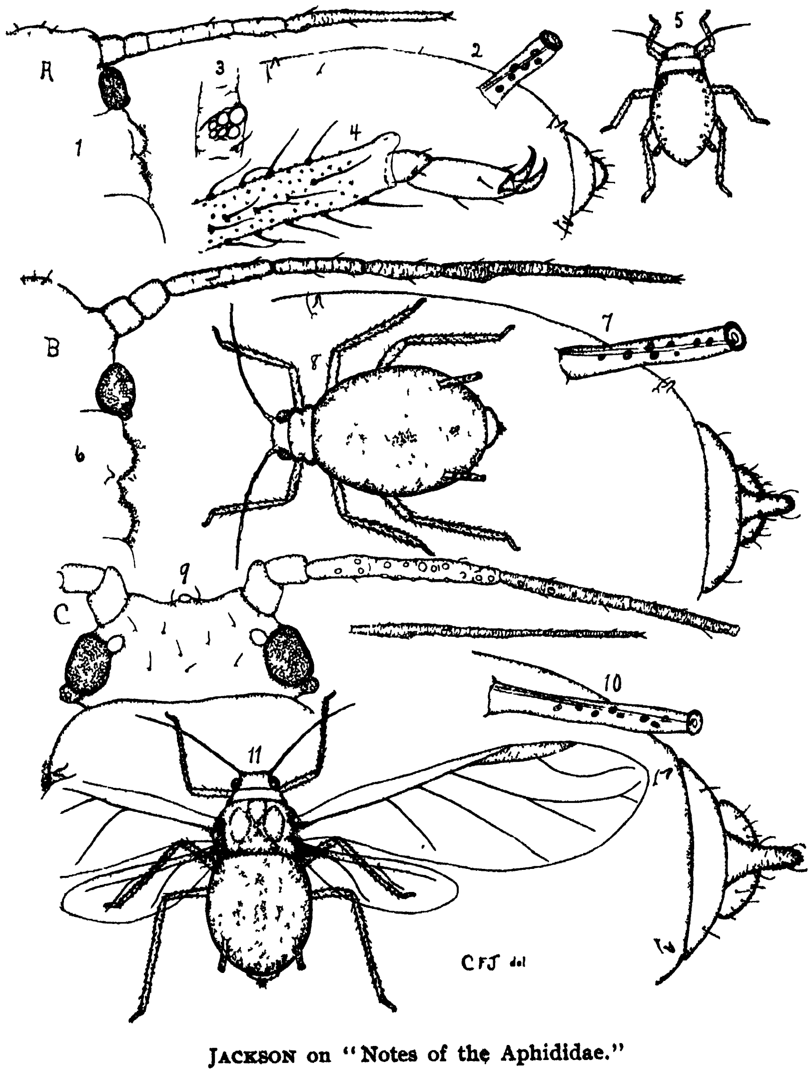
Two series of observations were carried on to determine the life history as well as the effect of food and other environmental changes on the species. The first set of observations was on the original colony which was not disturbed during the entire fall. As before stated when the aquarium was first brought into the laboratory it contained only wingless viviparous females or nymphs of the same. These were all very dark in color, varying from dark brownish black to nearly jet black. Being protected and in a warm room they multiplied at an enormous rate and in a few days everv available leaf of the *Philotria* was occupied and soon began to die. No sooner had the food supply began to fail than a change was noted in the color of the aphids, especially the very young. In place of being dark in color they assumed a greenish tinge and before long individuals might be found of a light pea green color. In a short time nymphs of the winged form were noted which rapidly developed and either migrated to one of the other aquariums, or flew to the window to die in a few days from starvation. Four or five other aquaria were in the laboratory and contained *Philotria* which was soon covered with aphids after the first winged forms appeared. Strange to say no sexual forms could be discovered and that phase of their life history is yet unsolved. In a little over a week after the aquarium was brought into the laboratory it was nearly depleted of aphids owing to the lack of food. However, as soon as the

great number of aphids had died or migrated the *Philotria* began to grow again and soon furnished an abundance of food, the return of which was accompanied by the appearance of dark colored aphids. This cycle has been repeated about twice since the middle of October and has not been interfered with or controlled in the least.

In the second series of observations food and temperature were the best that could be provided. In order to have some uniform system of elimination (as all of the individuals of ten successive generations reared would amount to millions) the first individual of each brood was all that was kept. These invariably developed into dark, almost jet black apterous viviparous females. From observing this set of aphids the following points in the life history were noted: The insect requires about twelve days to reach maturity. The first molt occurs about fifty hours after birth; the second two hundred after birth; the third two hundred and thirty; and the fourth three hundred or about twelve days after birth, depending somewhat on the food conditions. For an hour or so before molting the insect crawls about seemingly seeking a dry place in which to molt, but returning at once to the food plant after molting. Immediately following the fourth molt the adult begins producing young which continues from ten to twelve days. This makes the entire life of the individual twenty to twenty-four days, although occasionally an aphid will live several days after it ceases reproducing. By the time the adult dies her young have begun to bear offspring. About five are brought forth every twenty-four hours. This makes fifty offspring for one individual, two thousand five hundred for the second generation and over six million for the fourth generation. This of course is only under the best food and climatic conditions. However, under normal, or even poor food conditions, at least twenty-five individuals from each female will reach maturity if not molested by parasites.

In summing up the effect of environment on the life cycle under the most favorable food conditions, dark, apterous, viviparous females constitute by far the majority of individuals produced, and it seems that the first offspring of a brood always develop into this form, although winged forms may be among the last offspring produced. Under poor food conditions but normal temperature by far the large majority of aphids are winged, the apterous individuals when present being very light in color or only showing faint markings of black. The character and number of the offspring under given conditions is practically the same in the winged or wingless forms, although probably more individuals are produced by the apterous female. Unfavorable food conditions do not call forth the sexual individuals and I

OHIO NATURALIST. *Plate XVII.*



JACKSON on "Notes of the Aphididae."

believe that their production is dependent on either climatic conditions or changes in the food plant. At present further experiments are being conducted along this line. So far as I am informed this species has never been described or the peculiar adaptations of its structure to its semi-aquatic life noted.

Ohio State University, Columbus, Ohio.

NOTE.—Since this paper was written specimens have been received from Professor R. A. Harper, of Wisconsin State University which prove to be identical with this species. Professor Harper reports them very troublesome on a number of water plants in the University green house.

EXPLANATION OF PLATES.

A.—Nymph of apterous viviparous female before first molt

Fig 1. Dorsal outline of head and thorax, showing antennae. compound eye, thoracic tubercle, and the three thoracic wax glands. B. & L. 1 in —⅔ in.

Fig 2 Dorsal outline of the posterior region of abdomen showing honey-tube within which are small characteristic bodies and a fine tube which resmbles a trachea. Also the two abdominal tubercles, their accompanying hairs and the anal plate. B. & L. 1 in.—⅔ in.

Fig 3 Sensory pits at base of unguis. B & L. 1 in.—⅙ in

Fig. 4 Distal portion of tibia and tarsus, the former showing the regular arrangement of the long hairs, and also the pulverulent character of its surface. B & L 2 in.—⅙ in.

Fig 5 Dorsal view of insect. B. & B. 2 in.—⅔ in. with lower lens removed.

B.—Drawings of the adult apterous viviparous female.

Fig. 6. Outline of head showing adult form of Fig. 1. B. & L. 1 in.—⅔ in.

Fig. 7. Outline of abdomen showing adult form of Fig. 2 with cauda developed. B. & L. 1 in.—⅔ in.

Fig. 8. Adult apterous viviparous female. B. & L. 2 in.—⅔ in. with lower lense removed.

C.—Drawing of adult winged viviparous female.

Fig. 9. Outline of head showing ocelli and antennal sensories. B. & L. 1 in.—⅔ in.

Fig. 10. Abdomen of above. B. & L. 1 in.—⅔ in

Fig. 11. Adult winged viviparous female. B. & L. 2 in —⅔ in. with lower lense removed.

NOTE.—The above drawings were made with the use of the camera lucida at table distance. A Bausch and Lomb microscope was used with the combinations indicated.

New Books.

American Birds is the title of a neat volume by William Lovell Finley, and published by Charles Scribner's Sons. The illustrations are excellent and a score or more of species are treated in an attractive manner.

Although the author has been pleased to give the volume a broad title, the second paragraph of the introduction explains his aims and purposes. After stating that it is his purpose to consider only a few representative birds he continues by saying that "each chapter represents a close and continued study with camera and notebook at the home of some bird or group of birds —a true life history of each species." Such studies are commendable, for their appearance in print teaches one that there is much to learn about a species aside from its mere identification.

"Many of these studies were made in the West but in the list of birds treated an effort has been made to get a selection that is national in scope. In the popular mind a song sparrow is a song sparrow from ocean to ocean, yet scientifically he represents over a dozen subspecies, according to the part of the country in which he lives. To the ordinary bird lover, however, a robin is the same east and west, and the same is true of the chickadee, flicker, wren, grosbeak, vireo, warbler, hawk and others dealt with in the following chapters."

The author easily may find those who differ with him on some of these assertions. How natural it is for the "popular mind" to be attracted by characters which distinguish species, and what a satisfaction is felt when one specifically identifies the bluejay for the first time by its blue color and distinct crest.

Nesting methods, feeding habits, development of young and many other phases of bird life are either discussed or figured. Mr. Finley has given us a vast amount of information about a number of species and has advanced a line of bird study which is sure to attract many future students. J. S. H.

Natural History Survey.

A bill to provide for a Natural History Survey of Ohio has been introduced in the General Assembly by Mr. Crist of Delaware Co. and is now in the hands of the Finance Committee. This bill (House Bill No. 930) has the same provisions as the one introduced two years ago and a copy of which was published in a recent supplement of the NATURALIST. All who are interested in its passage are requested to write at once to the members of their acquaintance or to the representatives of their home county urging prompt and favorable action.

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THE EPI-BRANCHIAL PLACODES OF AMEIURUS.*

F. L. LANDACRE.

The study of the epi-branchial placodes of Ameiurus was taken up with the object of ascertaining to what extent they enter into the composition of the cranial nerves in this group of Teleosts.

The catfishes with their enormously hypertrophied system of gustatory nerves ought to have these placodes correspondingly prominent during embryonic development if they are concerned in the origin of the communis portions of the cranial ganglia.

Ameiurus has proven to be an unusually favorable type and a study of the development of its epi-branchial placodes suggests the idea that possibly the extremely divergent accounts given in the literature of these structures may be due to the choice of unfavorable types for study.

The extent to which communis fibres enter into the composition of the cranial nerves varies greatly even among the teleosts. There is probably a corresponding variation in the distinctness with which the placodes may be traced in the early development of those types in which the system is reduced. At any rate they are far more prominent and easily followed in Ameiurus than they seem to be in any other form described.

Aside from working out the details of their origin the following queries have been kept more or less constantly in mind:

(1) Do the cells derived wholly or in part from the placodes really become the communis ganglia of the adult?

(2) Are the placodal portions of the cranial ganglia pure—i. e., are the communis ganglia derived exclusively from the

* Read at the 1907 meeting of the Ohio Academy of Science.

placodes or they do contain cells derived from the neural crest or the mesectoderm?

(3) Are the placodes in their early growth and at the time of their origin proportionate in size to the communis ganglia of the adult?

(4) Is there any evidence that the placodes arise in response to a stimulus furnished by the neural crest portion of the cranial ganglia, as has been stated, or is there any evidence that they may be in part or wholly endodermic in origin?

(5) Lastly, if they are of pure ectodermic origin do they give rise to both general and special visceral fibres or only to special visceral fibres?

A brief description of the origin of the placodes will answer several of these queries.

In Ameiurus the placodes appear serially from anterior to posterior on the hyoid and first four true gills, none being developed on the fifth.

They arise in the ectoderm just dorsal and posterior to the gill slit at the time when the endodermic evagination comes into contact with the ectoderm.

Their presence is first indicated by a thickening of the ectoderm; this is followed by a period of active mitosis in the ectodermic thickening and a proliferation of cells into the mesoderm of the corresponding gill bar: This proliferated mass pushes its way posteriorally and dorsally and finally becomes detached from the skin which later assumes its normal thickness.

The proliferated masses especially in the IX and first two divisions of the X nerves are quite definite in outline and stain much darker than either the ectoderm from which they arose or the mesoderm. This difference in staining seems to be due to the amount and character of the intercellular substance. In the VII nerve the placode is so large and the proliferation of cells so rapid that in its earlier stages at least it is not so definite in outline as those of the IX and X, but in all cases from the time the proliferation begins the cell mass is easy to follow.

The size of the mass proliferated is apparently proportionate to that of the communis ganglia of the adult being largest in the VII nerve and much smaller in the IX and first two diivsions of the X.

The placode of the fourth true gill combines so closely with a neural crest portion that I am unable to compare it with the others.

All these ganglia of placodal origin have been followed up to a stage where the roots and chief trunks of the nerves are formed and there can be no doubt except in the third division of the X that they give rise to the communis ganglia of the adult.

As to whether these placodes may possibly be partly endodermic in origin or not can be answered in the negative without any hesitation. The relations in the VII are somewhat confused owing to the rapid proliferation of cells which seems to push the ganglion forward into contact with the endoderm but I believe this placode is also purely ectodermic.

The important question to be determined here is of course, whether these placodal masses contain cells derived from the neural crest or from the mesectoderm.

They certainly do not arise in Ameiurus in response to stimuli furnished by the contact of neural crest cells with the skin. There are no neural crest cells that can be distinguished as such, that come into contact with the skin where the placodes arise except in the third division of the X nerve.

If the placodes arise in response to any stimulus furnished by the embryo, it is much more probable that it is the stimulus derived from the contact of the endodermic evagination that forms the gill slit.

The contact of this evagination which occurs even in the VII nerve is coincident with or closely associated with the appearance of the placode and while there may be no causal relation it is a striking fact and may be fundamental.

In the third division of the X nerve the neural crest mass comes into contact with the skin about the time the placode appears and the relation of the neural crest cells and of the placodal cells is so intricate that I have been unable as yet to separate them. This seems to me, however, to call for a different interpretation from the one mentioned above.

While there are no definite masses of neural crest cells added to the placodes except in the third division of the X nerve, it is much more difficult to be sure as to whether cells usually designated as mesectoderm may be incorporated with those derived from the placodes, particularly in the VII nerve.

The visceral portions of the IX ganglia and of the first two divisions of the X seem to be pure placodal ganglia.

In the VII where the placode is large and the proliferation of cells rapid the borders of the growing ganglion are not so definite and there may be a small portion of the ganglion that comes from the mesectoderm and is not derievd from the placode. It must, however, be very small. So that we can say for this type that the communis ganglia of the IX and the first two divisions of the X are practically pure placodal ganglia, that there is more doubt about the gerniculate ganglion, although even here the incorporated portion must be very small; while in the third division of the X there is a large neural crest portion which combines with the placodal portion so intimately that it is not possible to distinguish them.

As to whether the placodal portions of the communis ganglia give rise to special visceral fibres only, or to both special and general visceral fibres there is less certainty. The facts on which we may hazard a conclusion are as follows:

Every cranial nerve containing gustatory fibres comes from a ganglion which can be traced wholly or in part to an epi branchial placode. The VII, the cranial ganglion supplying by far the largest number of gustatory fibres comes from the largest epibranchial placode.

The X, the cranial ganglion supplying the largest general visceral component contains the largest neural crest element.

The smallest general visceral component is apparently in the VII nerve and there is possibly a small neural crest element in the gerniculate ganglion.

The IX nerve is most interesting in this connection. I am unable to find any neural crest cells in the communis ganglion of the IX nerve and Professor Herrick describes it as supplying taste buds throughout its whole area of distribution and makes no mention of its supplying general mucuos surfaces.

If this is true we have a pure special visceral or gustatory nerve coming from a pure placodal ganglion in the case of the IX, and a very reasonable deduction from this is, that the placodes give rise to that portion of the communis ganglion which supplies special visceral or gustatory fibres, the portion supplying general visceral fibres coming from the neural crest.

The latter is homologous then in origin with the general visceral ganglia of the cord, but differs from them in that it dissociates itself from the general cutaneous cranial ganglia and fuses with that derived from the placode.

The general cutaneous ganglia of the cranial nerves are quite distinct and there is even less excuse for confusing the cutaneous and visceral ganglion in the embryo than there is in the adult.

If the epibranchial placodes give rise to the gustatory portions of the communis ganglia, we must look on the gustatory nerves as comprising a special visceral system because they end in visceral centers in the brain, and not because of any similarity in origin of the general and special visceral ganglia or because of the method of distribution of the gustatory organs.

The ganglia are in no immediate sense related to general visceral ganglia in mode of origin, and the gustatory organs are highly specialized and may be mainly ectodermic in position so that I think the term special communis ought to be applied with central brain connections always in mind as the justification for the term and this seems to be generally done.

This generalization in regard to the origin of the gustatory fibres is too far reaching to be rendered safe by a study of one

type. Other teleosts in which the gustatory system is reduced as compared with Ameiurus, as well as Cyclostomes, Elasmobranchs and Amphibia must be studied with this particular point in view.

In other forms the neural crest element is apparently fairly constant in those nerves which contain gustatory fibres. The small size of the special visceral component and of the placodes in these types may account for the idea that the placodes arise in response to the stimulus furnished by the contact of the neural crest with the skin. The catfishes, however, are unique in the size of their placodes and of their special visceral component.

And if the IX ganglion should prove not to be a pure placodal ganglion and the IX nerve of the adult does supply general visceral surfaces, I still think the evidence very strong that the placodal portions of these ganglia give rise to the special visceral or gustatory fibres.

And the special visceral system bears the same relation to the general visceral that the Acustico-lateralis system bears to the general cutaneous.

ON THE ORIGIN OF POLAR CONJUGATION IN THE ANGIOSPERMS.

JOHN H SCHAFFNER.

Various attempts have been made to explain the probable origin of the remarkable structures and activities present in the embryosac of the Angiosperms. These attempts, however, resulted in mere hypotheses with few or no known facts in their favor to recommend them for serious consideration. With the recent great advance in our knowledge of the female gametophyte of the Gymnosperms, due to the thorough work of a number of zealous observers, has come the opportunity for a reconsideration of the problem in the light of the new discoveries. Porsch[1] has done this in a very interesting and convincing paper in which he presents very strong evidence for his views.

He holds that the two synergids of the Angiosperms are neck canal cells homologous with the neck canal cells of the Gymnosperm archegonium; that the oospheres of Gymnosperms and Angiosperms are homologous cells: and that the upper polar, which is a sister cell of the oosphere, as determined by various observers for different plants and very definitely by the writer for Erythronium,[2] is the homologne of the ventral canal cell of the Gymnosperm archegonium. He holds further that the

1 PORSCH, OTTO. Versuch einer phylógenetischen Erklarung des Embryosackes und der doppelten Befruchtung der Angiospermen. Verlag von Gustav Fischer in Jena. 1907.

2 SCHAFNER, JOHN H. A contribution to the Life History and Cytology of Erythronium. Bot. Gaz. 31 : 369–387. 1901.

lower end of the Angiosperm embryosac is the morphological equivalent of the upper, the lower polar being thus also homologous to a ventral canal cell. In other words, the typical embryosac or female gametophyte of the Angiosperms, with its symmetrical arrangement of four cells at opposite poles, represents two archegonia, the vegetative cells having disappeared.

There is much in favor of this theory from the standpoint of the writer. In 1896, in my paper on Alisma plantago,[3] I made the statement that "Especially in regard to the real meaning of the conjugation of the polar nuclei, and what is represented by the antipodal cells, does there still seem to be much obscurity." But my study of the Angiosperm embryosac gave no light on these two important questions except that I observed the following facts: "The cells in the antipodal region simulate the arrangement in the egg-apparatus. There are two small nuclei lying at the base; and beyond them is the third antipodal nucleus." "It would by its peculiar appearance suggest that it may be *the homologue of the oosphere*." (Italics not in the original.)

Chamberlain[4] had, in 1895, figured and described what he felt positive was a veritable oosphere in the antipodal region of Aster. It would appear that the extensive antipodal region of Aster still has the ability to develop a structure very similar in appearance to the micropylar egg apparatus. Chamberlain, however, did not take advantage of his remarkable discovery to assert the similar nature of the two ends of the sac, being probably hindered from doing so by a too strict adherence to the prevailing hypothesis that the antipodal region represents the vegetative thallus of the Angiosperm female gametophyte.

If Porsch's view of the homologies is correct, it becomes evident that we have, as he ably shows, an easy explanation of the origin and nature of the triple fusion process, or what has improperly, to my mind, been called double fertilization, which appears to be so common in the Angiosperm sac.

I wish to add an explanation of certain peculiarities not specially touched upon by Porsch. In my paper on Sagittaria latifolia[5] I made the following observations: " approaching each other the upper larger polar nucleus travels much farther than the lower one, so that the place of contact is usually in the lower part of the embryo sac, and the fusion takes place here without any apparent shifting of the nuclei, *the fusion being usually complete before the entrance of the pollen tube into the sac.*"

3 SCHAFFNER, JOHN H. The Embryosac of Alisma Plantago. Bot. Gaz. 21 · 123–132.

4 CHAMBERLAIN, CHAS. J. The embryo-sac of Aster Novae-Angliae. Bot Gaz. 20 · 205–212.

5 SCHAFFNER, JOHN H Contribution to the Life History of Sagitaria variabilis. Bot. Gaz. 23 : 252–273, 1897.

(Italics not in the original.) The pollentube is so remarkably distinct in Sagittaria and produces such marked changes that I am certain I could not have overlooked it in the stages where polar conjugation takes place, especially since the study of the pollentube was one of the main objects of this investigation.

Thus it is certain that in some plants the polar nuclei have learned to conjugate without the influence of the second sperm nucleus or even the pollentube. The question now arises as to how the polars acquired this remarkable ability if they do not represent opposite sexes. For it seems excluded that one could think of the Angiosperm female gametophyte as being a direct descendant of an hermaphrodite thallus, the polar nuclei being descendants from male and female gametes. It is altogether probable that the Angiosperms passed through the Heterosporous Pteridophyte stage before becoming seed plants. Porsch's view, therefore, seems the correct one, that the triple conjugation results from the essentially female character of the polars. If therefore a conjugation takes place without the presence of the second sperm, this must be looked upon as a special sort of parthenogenetic development. All polar conjugations, accordnig to this view, had their origin in the original conjugation of one or both polars with the second sperm, typically in the second way through triple fusion.

Now the question arises as to whether there is a triple fusion in Sagittaria and other such cases. Does the second sperm come down later and fuse with the polars acquired the property or function of conjugating with each other through their common attraction to the second sperm with the first upper endosperm nucleus after the partition wall is formed at the end of the division of the definitive nuclues? This division takes place about the same time as the first division of the oospore, and such a possibility is suggested by the following facts: The second sperm seems to remain in the tube for some time after the first one escapes to unite with the egg; the upper endosperm nucleus, immediately after the division of the definitive nucleus, begins to travel upwards; the lower endosprem nucleus presents a remarkably different development from the upper one. But no weight is to be attached to the suggestion until further investigations are made.

True endosperm, as has been suggested by several investigators, may be present even in Gymnosperm archegonia. A true endosperm might originate from the division of a ventral canal cell without conjugation of the second sperm with the ventral canal cell. In Angiosperms an endosperm might result from the conjugation of either polar nucleus with the second sperm; from the conjugation of both polars with the second sperm, which seems to be the usual mode; or through partial

parthenogenesis from a definitive cell in the formation of which the two polars alone are concerned; or even possibly from a single polar cell. The lack of fusion of the polars, if such condition exists, may represent either a primitive condition or a more recent, parthenogenetic condition. Theoretically, therefore, it is possible to have an "x" endosperm generation of two different origins, a "2x" endosperm generation of two types differing in constitutional structure, and a "3x" endosperm generation, but none of these could properly be called an embryo.

Botanical Garden, Univ of Zurich, Nov 25, 1907.

SOME OBSERVATIONS CONCERNING THE EFFECTS OF FREEZING ON INSECT LARVAE.*

James S Hine

It has been known for a long time that some insect larvae can withstand low temperatures without being noticeably injured thereby. Also that there is great difference among species of insects, or in some cases even among the individuals of a single species, in regard to the minimum temperature at which life is endangered. Economic entomologists have now and then made the claim that frosts, especially when they occurred at certain seasons, have been important factors in the control of injurious species.

In 1893 while studying the life history and habits of a moth, Bellura obliqua, which passes its larval stage in the stems of the cat-tail reed, Typha latifolia, I had an opportunity to make some observations on larvae of this species which are normally found in the reeds throughout the winter. The winter was rather severe for the latitude of Columbus where the observations were made, and from January 10 to January 20, the temperature dropped below zero every night, varying from -2 Fahr. on the 10th, to -17 on the 17th. Large numbers of the larvae were collected during this interval, some during each day, and with the specimens some tests were made. Three larvae collected on the 14th, were placed in water and placed outside on a porch roof during 12 hours the following night when the minimum temperature recorded was -15. The next morning the specimens were brought inside and thawed out, after which they were taken from the water and kept in a tin box at the temperature of a living room for about 12 hours. These same larvae received the same treatment for six consecutive nights and days, during the time withstanding a minimum temperature of -11 on the

* Read before the Ohio Academy of Science, Nov. 30, 1907.

15th, -6 on the 16th, -17 on the 17th, -6 on the 18th, -14 on the 19th, and -16 on the 20th. None of the specimens showed signs of injury from the treatment.

Three other larvae taken on the 14th, and treated exactly as the above except that water was not used received no noticeable injury.

Three larvae taken on the 14th, and frozen in water and kept at outdoor temperature for a week fully revived when thawed out again.

Larvae collected just after daylight on January 20, when the thermometer registered -15 could be snapped in two almost like icicles and crystals of ice were observed within their body cavities. Some of these pieces were alive when thawed out at the end of a week.

Under natural conditions the larvae were to be found wherever they happened to be when freezing temperature caught them. Some in the centers of the reeds, some protected by only one or two thin leaf-sheaths, some at distances above the snow ranging from an inch or two up to two feet, or even more, and some beneath the surface of the ground near the roots of the plants.

In order to bring out a striking difference in results I wish to give my observations on the larvae of the common Hawk-moths of the tomato, two species of which are about equally common in the state. During the Fall of 1896 these larvae were abundant on tomatoes and when time for the first frosts arrived not all the specimens had reached the mature larval condition and entered the ground for pupation. Larvae of different sizes therefore were observed feeding actively on the tomato vines the day before the first frost came. The frost was not a hard one but the exposed parts of the vines were killed as were the larvae on these parts. Larvae on the parts of the vines that were not killed kept on feeding the following day, but a frost the next night killed most of the leaves that had escaped the previous night and with them the remaining larvae.

Previous to 1903, for several years canker worms were abundant on the elm trees along the river on the Ohio State University farm. During April of 1903 the warm weather hatched the eggs of the Fall Canker-worm and the larvae started in to cause havoc among the elm leaves, but a frost on May 4, killed so many of them that they have not been a serious pest since. It may be stated that A. F. Burgess made a similar observation in regard to the Spring Canker-worm on apple the same Spring, and those who have observed know that the latter species has not done the damage since 1903 that it did the few years previous to that year.

A quotation from an account of Sir John Ross's second arctic voyage recording experiments carried out with a moth, Laria rossi, has a bearing here:

"About thirty of the caterpillars were put into a box in the middle of September, and after being exposed to the severe winter temperature of the next three months, they were brought into a warm cabin, where, in less than two hours, every one of them returned to life, and continued for a whole day walking about. They were again exposed to the air at a temperature of about -40, and became hard frozen immedately; in this state they remained a week, and on being brought into the cabin again, only 23 came to life. At the end of four hours these were put out once more, and hard frozen again; after another week they were brought in, when only 11 were restored to life. A fourth time they were exposed to the winter temperature, and only two returned to life on being brought into the cabin again. These two survived the winter and in May an imperfect moth was produced from one, and six parasitic flies from the other."

From what has been said it is evident that some larvae will not be killed by very low temperatures, while others may be killed by a frost that is sufficient to kill tender foliage, also that all the difference is not in the species, for some specimens may be killed while others of the same species are not killed by the same exposure.

P. Bachmetjew of Bulgaria, has published an extended paper in *Zeitschrift fur wissenschaftliche Zoologie* for 1899, from which the following conclusions are extracted:

"The thawing out of insects after their body fluids have been frozen has no noticeable influence upon their return to life, but only upon the intensity of their vitality."

"The critical point is not the same in different species, nor in different individuals of the same species."

"The longer an insect has gone without food, the lower is the normal freezing point of its body fluids."

"Repeated freezing lowers the critical point and also the normal freezing point of the body fluids."

THE EMBRYOLOGY OF OXALIS CORNICULATA.*

HOWARD S. HAMMOND.

Oxalis corniculata might be called a sub-tropical plant although it is frequently found growing in ballast about the Eastern seaport towns of the United States and becomes quite abundant in Texas. In tropical America it is quite common and is also reported as occurring in the tropical regions of the Old World. It has been reported as far north as Ontario. Frequently it is found growing on the ground in greenhouses where it blooms profusely throughout the year. It was under these last named conditions that the writer secured the material with which he worked. The material was collected throughout the Spring of 1906 and the Fall and Winter of 1906–1907. The usual methods of killing and imbedding were used. The sections were cut 8 mic. thick and stained on the slide. Delafield's Haemotoxylin proved the most satisfactory stain. To Prof. John H. Schaffner under whose direction this study was begun and to Prof. Robert F. Griggs under whom the study was completed I desire to express my sincere thanks for their kind assistance and suggestions.

MEGASPORES AND EMBRYO SAC.

The nucellus consists of a single axial row of cells invested by the epidermis (Fig. 1). The uppermost cell of the axial row is the archesporium which, thus appearing very early, increases to two or three times its original size. It does not give rise to parietal tissue but undergoes directly the Reduction Division which was not observed (Fig. 2). The lowest of the three or four megaspores thus formed becomes the functional one, and rapidly enlarges at the expense of the potential ones above, giving rise to the two (Fig. 3), four (Fig. 4), and eight (Fig. 6), celled embryo sacs in the usual manner. Before the two celled embryo sac is formed the surrounding epidermis which functions as tapetum, has begun to disintegrate and the sac is subsequently enclosed simply by the integuments. The embryo sac develops very rapidly and is nearly straight although the ovule is anatropous. The antipodals are small, stain darker than the polar nuclei or the unfertilized egg, and begin to disintegrate at the time of the conjugation of the polar nuclei (Fig. 6), sometimes disappearing before fertilization in case that is delayed till after the polar nuclei have fused (Fig. 5). The synergids stain dark, are rather large, and also disintegrate early, one of them being destroyed by the entrance of the pollen tube (Fig. 6).

ENDOSPERM AND EMBRYO.

Connecting the endosperm cells are radiations, as has been frequently observed in many plants, but these are not kino-

* Contributions from the Botanical Laboratory of the Ohio State University, XXXIII.

plasmic in appearance but rather consist of a radial arrangement of ordinary cytoplasm. They do not lead to cell formation although a small amount of endosperm persists until the seed is nearly mature.

After fertilization the egg elongates and forms a pro-embryo four cells in length. There seems to be a more or less constant transverse division in the second cell of the pro-embryo, thus foreshadowing the massive suspensor (Figs. 8 and 9). The two suspensor cells thus formed by division together with the basal cell flatten against the wall of the integuments and give a foot-like appearance to the base of the suspensor, and form a haustorium like organ which maintains its activity, judging by its staining reaction, till the embryo is mature, although the upper cells of the suspensor may begin to break down before that time (Figs. 10, 12, 16 and 17). This organ burrows its way into the integuments until it reaches the testa forming a ball of tissue which may, apparently from the division of the original three, consist of a number of cells. The third cell of the pro-embyro probably forms the remainder of the suspensor consisting usually of three tiers containing one or two rows of cells (Figs. 13–16). The suspensor is rather short, forms no part of the embryo, has no hypophysis as has long been known for Geranium,* nor does it form the rootcap. As the embryo matures the dermatogen and calyptrogen are extended around the tip of the hypocotyl. The calyptrogen and calyptra are differentiated from this in the usual way. With advanced growth they completely surround the hypocotyl and form the root cap (Figs. 15 and 16), which is for a time distinctly concave at its junction with the suspensor till that organ disintegrates and disappears. With this exception, the general development of the embryo is similar to the Capsella type. The cotyledons arise from the opposite points of the almost spherical embryo in the usual dicotyl manner with the plumule between them.

SUMMARY.

1. The archesporium is a single sub-epidermal cell and becomes the functional megaspore directly without forming parietal tissue.
2. The whole nucellus functions as tapetum.
3. The antipodals and synergids disappear soon after fertilization.
4. The embryo forms no hypophysis.
5. A multicellular haustorium-like organ is formed from the basal cells of the suspensor which forces its way through the integuments until it reaches the testa.

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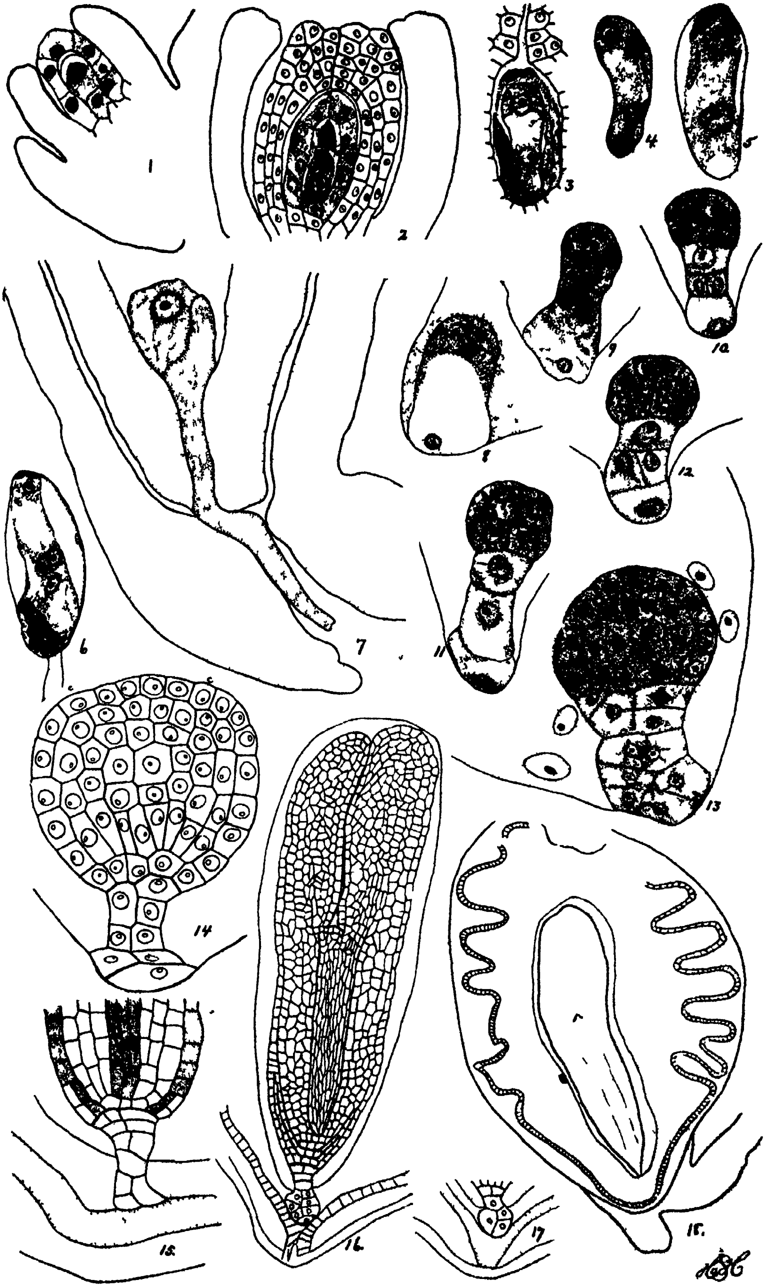
* Coulter and Chamberlain, Morphology of Angiosperms. 200. 1903.



HAMMOND on "Oxalis Corniculata"

LITERATURE.

The literature bearing on the morphology of Geraniales is very scarce. The following works bear slightly on the subject.

Britton, Nathaniel Lord, Manual of the Flora of the Northern United States and Canada. 1905.

Coulter and Chamberlain, Morphology of Angiosperms. 1903.

Rosendahl, C. Otto, Preliminary note on the Embryogeny of Symphocarpus foetidus, Salisb. Science N. S. 23: 590. 1906.

Schaffner, Mabel, The Embryology of the Shepherd's Purse. Ohio Nat 7 : 1–8, pls. 1–3, 1906.

EXPLANATION OF PLATES.

All drawings were made with a Bausch and Lomb microscope with the aid of a camera lucida. In reproduction they were reduced to one-third their original size. The following combinations of oculars and objectives were used:

Figs. 1–14, oc. ½ in., obj. 1-6 in. Magnification 720.
Fig. 15, oc. 2 in., obj 1-12 in. Magnification 470.
Figs., 16 and 17, oc. 2 in., obj. 1-6 in. Magnification 205.
Fig. 18, oc. ½ in., obj. 2-3 in. Magnification 146.

Fig. 1. Young ovule with archesporial cell. × 360.

Fig. 2. Large megaspore with non-functional ones above it. Nucellus beginning to disintegrate. × 360.

Fig. 3. Two celled embryo sac. × 360.

Fig. 4. Four celled embryo sac. × 360

Fig. 5. Seven celled embryo sac with the antipodals completely disintegrated. × 360

Fig. 6. Eight celled embryo sac showing entrance of pollen tube hiding disintegrating synergid. Polar nuclei uniting and antipodals beginning to disintegrate. × 360

Fig. 7. Fertilized egg and pollen tube. × 360.

Fig. 8. The three celled pro-embryo. × 360

Fig. 9. Six celled embryo showing first appearance of the embryo proper. × 360.

Fig. 10. Young embryo showing the octant stage and the division of the central suspensor cell by a longitudinal wall. × 360.

Fig. 11. Slightly older stage in the growth of the embryo The central suspensor cell undivided. × 360.

Fig. 12. Somewhat more mature embryo showing the beginning of dermatogen. × 360.

Fig. 13. More advanced embryo showing the beginning of the multicellular suspensor, dermatogen completely differentiated. × 360.

Fig. 14. Embryo showing the origin of the cotyledons by the bulge on the opposite sides. Foot-like expansion of the suspensor becoming prominent. × 360.

Fig. 15. Base of half-grown embryo showing differentiation of tissues at the root tip. × 235.

Fig. 16. Nearly mature embryo showing different tissues and the multicellular base of the suspensor piercing the integuments and reaching the testa. Cotyledons obliquely cut so as to mask the regularity of tissue. × 100.

Fig. 17. Haustorium-like region in the base of the suspensor. × 100.

Fig. 18. Cross section of seed showing the mature embryo and corrugated testa. × 75.

SOME NOTES ON PHILOMYCUS.

V. Sterki.

Philomycidæ is a family of nearctic shelless land snails, or slugs. There has been a great deal of controversy with respect to the generic names, and also discussion on some of the species. The genus *Philomycus* was proposed by Rafinesque as "differing from Limax by no visible mantle." That was a mistake: the mantle covers the whole body except the front part of the head when the animal is extended, and a narrow seam along the sides of the sole. For that reason the genus was not recognized by Binney and other authors, and *Tebennophorus* Binney took its place. Yet, no one doubts now that *Philomycus* really means the same, and it is but just to revert to the earlier name. Rafinesque also established the genus *Eumelus* as distinct from Philomycus by the position of the tentacles, a feature which seems unintelligible. Later, E. S. Morse established the genus *Pallifera* on the ground that the jaw of *Ph. dorsalis* is strongly ribbed, odontognathous, while that of *Ph. caroliniensis* is smooth, and somewhat oxygnathous. But other species show intermediate forms.

These interesting slugs are still insufficiently known, as to both their systematic position and distribution, and it is very desirable that they be worked up from good material. Students of nature are respectfully and urgently invited to collect specimens wherever encountered, and to send them for examination, living if possible, with a little damp moss, or alcoholic, (in which condition, however, they are badly contracted). They are mostly found retired, under loose bark and in cavities of dead tree trunks and stumps, preferably in damp, shady places. At night, they sometimes ascend trees. They may be found also in winter time, during open weather; entomologists and collectors of cryptogams thus may have chances to take the slugs. It is hardly necessary to say that they are not venomous and cannot bite, as is believed by some people.

For the benefit of those who collect them, and naturally want some information about them, it may be in place to add a few notes with respect to the species and forms which have been seen from Ohio or can be expected to be found in the state.

As pointed out, *Philomycus* is distinguished from *Limax* by the mantle extending over almost the whole body, while in the latter genus it covers only about the anterior half. Besides, there are other morphological and anatomical differences.

1. *Ph. caroliniensis* Bosc. (Limax caroliniensis Bosc, Tebennophorus caroliniensis, in Binney, etc.), regarded as the type, attains a length of 100 millimeters when extended, but

usually is found smaller. The back (mantle) is whitish to pale tan, or grayish, "with clouds and spots of brownish and blackish so arranged as to form three ill defined longitudinal bands." On the variations of color, Binney has noted seven varieties, not named, and it has been suggested, recently, that at least some of them are probably distinct species. The question should be settled by examining the jaw, radula, genital organs, etc.

2. *Ph. dorsalis* Binney (Pallifera dorsalis, in Morse) is the smallest known now, the animal attaining a length of only about eighteen millimeters. Its color on the dorsal side is gray with a shade of blue, and a more or less interrupted dark median line. It is probably distributed all over Ohio, but has been overlooked or taken for the young of some other slug.

3. *Ph. sp.* I collected two specimens in the woods east of Chippewa Lake, the only ones known from Ohio. They were 30 millimeters long when extended, very slender, light tan colored over the back, with very slight darker mottlings, the sole anteriorly with a tinge of blood red. The jaw and radula were different from those of other species. Being possibly identical with *Ph. pennsylvanicus* Pilsbry, they were left unnamed for the present.

4. *Ph. sp.* Of the same size as *caroliniensis* or rather somewhat larger. The body is less opaque, and the surface gyrations are somewhat different. There is a series of irregular black spots along each side, and small irregular white spots are scattered over the whole mantle surface. Jaw and radula are different. Fifteen and twenty years ago, this was found rather frequently in the vicinity of New Philadelphia, in company with *caroliniensis*, and taken for one of the color varieties of the latter. Both are more scarce now. Specimens carefully examined last summer showed that they are of a distinct species, which will doubtless be found in other parts of the state. It has been named *Ph. biseriatus.* provisionally.

5. *Ph. wetherbyi* W. G. Binney has not been recorded from Ohio; but known from Kentucky (Laurel County), and also from northern Michigan, it should be found within our limits. It is rather small, with dark blotches in irregular transverse bands or longitudinal series. The jaw and radula are different from those of other species.

Other forms, and species may be found, and it is unnecessary to state that every specimen from any part of the state will be of interest.

MEETINGS OF THE BIOLOGICAL CLUB.

ORTON HALL, Oct. 7, 1907.

On the above named date the Biological Club met in its usual place, with Prof. Griggs as chairman pro tem. The evening was devoted to reports on summer's work, Prof. Hine opening the program with an account of his trip through the western states and south into Mexico. This was followed by a brief account by Prof. Osborn on the proceedings of the International Zoological Congress which met this year in Boston. Mr. Jackson gave an account of his trip up the Tippecanoe River, Indiana.

Prof. Griggs was next in order with a talk on his work on Kelps at the Minnesota Seaside Station on Vancouver's Island.

Mr. S. Morgulis spoke of the advantages of the Biological Laboratory at Wood's Holl, Massachusetts. Mr. W. C. Morse reported finding a glaciated surface north-east of Hayden's Falls.

The following names were proposed for membership: Dr. Alfred Dachnowski, Messrs. S. Morgulis, H. H. Severin, H. C. Severin, E. M. Allen, Geo. W. Hood, E. B. Blakeslee, L. L. Scott, J. A. Zimmer, H. E. Evans, E. Kinney, M. F. Osborn, H. T. Osborn, R. J. Sim, Chalmers DePue.

The society directed the President to appoint a nominating committee to report at the next meeting, after which the club adjourned to meet the first Monday in November.

H. S. HAMMOND, Sec. pro tem.

ORTON HALL, Nov. 4, 1907.

On the above named date the Biological Club met in Orton Hall and after being called to order by President Hambleton the minutes of the previous meeting were read and, after corrections, approved. Then the President called for the report of the nominating committee composed of Prof. J. S. Hine, Miss Freda Detmers and Mr. W. C. Morse. The committee's report was adopted, consisting of the following names. For President, Prof. Geo. D. Hubbard; Vice President, Miss Stella Wilson; Secretary-Treasurer, Arthur H. McCray.

The address of the evening was given by the retiring President, Prof. J. C. Hambleton, who gave a very interesting and instructive account of a four years' residence on the island of Chiloe off the coast of Chili and a province of that country. The people of this island while not blessed with nature, as some people, have adapted themselves in a remarbable manner to their environment. In the remarks and discussions consequent upon the address the following took part. Prof. Hubbard, Prof. Osborn Prof. Hine, Prof. Griggs and Mr. Chew.

D. C. Mote and K. H. Chew were proposed for membership, and the names proposed at the previous meeting and mentioned in the minutes, were elected to membership, after which the club adjourned.

ARTHUR H. McCRAY, Secretary.

ORTON HALL, Monday, Dec. 2, 1907.

On the above named date the Biological Club met in its usual place and was called to order by the President. The minutes of the previous meeting were read and, after corrections were made, were approved.

Reports from the meeting of the Ohio Academy of Science held at Oxford, Ohio, were called for. Professors Hine, Osborn and Hubbard gave brief reports, and Mr. Morgulis read two of his own papers presented at the meeting.

The paper of the evening was presented by Mr. C. F. Jackson on "Some Modern Conceptions of Evolution as applied to the Aphididae." First, the definition and position of the family were taken up, followed by notes on life history. This proved most interesting, because of the great numbers of these insects which are produced without fertilization.

After the completion of the program, the names proposed at the previous meeting were elected to membership. The following new names were proposed for membership: V. L. Wildermuth, T. H. Parks, R. E. Hundertmark, H. Barber, E. J. Hoddy, M. Denny, M. E. Corotis, B. Anspon. The Club then adjourned to meet in four weeks.

ARTHUR H. McCRAY, *Secretary.*

ORTON HALL, Monday, Jan. 6, 1908.

On the above named date the Biological Club met in its usual place, and the minutes of the previous meeting were read and approved. On account of the Secretary asking for an expression from the Club as to whether the minutes should include a brief review of papers presented at the meetings, Prof. Hine made a motion, which was carried, that the minutes include reports of those papers not published in the NATURALIST.

The paper of the evening was presented by Mr. Sergius Morgulis on "Regeneration: Facts and Reflections." Regeneration may be regarded as one of the fundamental properties of living matter. Nails, hairs, nerve fibers and nerve tissue may be replaced, while in lower organisms, as in salamanders, gills, jaws, eyes, and limbs, can be regenerated.

After this paper reports were given of the Chicago meeting of the American Association for the Advancement of Science. The following reported: Professors J. C. Hambleton, W. R. Lazenby, Osborn, Dacknowski, Detmers. Miss Katybel Hyde and D. M. Segovin, as well as those proposed at the previous meeting, were elected to membership. The club then adjourned.

ARTHUR H. MCCRAY, *Secretary.*

ORTON HALL, Monday, Feb. 3, 1908.

The Biological Club on the above named date, met in Orton Hall as usual, and the minutes of the previous meeting were read and approved. The name of Miss Emily Hollister was proposed for membership.

Prof. Landacre gave an excellent report of the neurological papers presented at the Chicago Meeting of the A. A. A. S.

The paper of the evening was presented by Dr. Hubbard on "Drainage Modifications near Lakeville, Ohio." A series of stream modifications has taken place here, which seems to be most plausibly explained by attributing it to glacial action.

In reports of personal observations, McCray mentioned observing last fall an unusual number of honey bees working on red clover. Prof. Hine reported the securing for the department of Zoology a Black Backed Gull, perhaps about the second authentic record of this bird for Ohio. R. J. Sim reported that a specimen of Brunnich's Murre was taken in Ashtabula County, Ohio, during the holiday vacation. This is the second recorded occurrence of this bird for the State.

The Club adjourned to meet in four weeks.

ARTHUR H MCCRAY, *Secretary.*

BOOK REVIEW.

It gives us pleasure to quote the following from a prominent teacher of chemistry who has been using McPherson & Henderson's text since its publication by Ginn & Co. some two years ago: "This text has now been tested by use. This test has shown the book to be possessed of many excellent qualities. Unlike many text-books it may be put into the hands of the student for the purpose of instructing him and without fear that he may be hopelessly confused. Yet while it possesses this

quality it is none the less accurate. This shows that the book was written by men who are familiar with the art of teaching. The clear statements, the logical development of the subject, and the rigid scientific accuracy are silent testimonials to the ability of the authors. The same authors have prepared a laboratory manual to accompany this text. It is useless to say it possesses the same merits as the text. It gives the student ample instructions without reaching all of his conclusions for him. This manual causes the student to work and makes him think while he works."

J. C. H.

Date of Publication, February 15, 1908

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TABLE OF CONTENTS.

THE DEVONIAN SECTION ON TEN MILE CREEK, LUCAS COUNTY, OHIO.

CLINTON R. STAUFFER.

The Devonian formations of Ohio are fairly well known in those portions of the state where they constitute the bed rock. This is especially true in the central strip of outcrop where the shales and limestones of this System sometimes form cliffs fifty to seventy-five feet high. In northwestern Ohio, however, the land lies but little above drainiage level and the covering of drift is frequently so deep that the streams do not cut through it. Hence our knowledge of most of the Devonian formations in this portion of the state is limited to a few outcrops with incomplete and more or less unsatisfactory sections.

In this northwestern area, the Columbus limestone[1] is extensively quarried at White House and occasionally, on a much smaller scale, at a number of other places. The Delaware limestone forms only occasional and meagre outcrops, while the Olentangy shale is either entirely wanting or is inseparable from the other Erian formation. The Ohio shale outcrops at several

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(1) Ohio Classification of the Devonian and extreme upper portion of the Silurian as approved by Dr. Charles S. Prosser

Devonian	Chautauquan and Senecan	Ohio shale	Cleveland sh. Chagrin form. Huron sh.
	Erian	Olentangy shale Delaware limestone	
	Ulsterian	Columbus limestone	
UNCONFORMITY			
Silurian	Cayugan	Monroe form.	Lucas ls. Sylvania ss. Tymochtee form.

places along Auglaize and Maumee Rivers and a calcareous layer occurring near the base of the formation was formerly used in the manufacture of cement at Defiance.

These Devonian outcrops received some attention from the members of the State Geological Survey during the seventies and a report of their work is given in the publications of the Survey at that time. A section which escaped notice, probably because it was then largely covered, is to be found along Ten Mile Creek. This stream flows across the northen portion of Lucas County and empties into Maumee Bay at the state line. Near Silica, eight miles west of Toledo, the creek crosses a slightly drift covered limestone ridge which extends southward from Michigan into Oiho. During the summer of 1906, the channel was artificially deepened and at that time an excellent outcrop of rock was laid bare. The section is similar to that discussed by G. K. Gilbert[2] except that it includes more of the Devonian. It is to these upper strata of the following section that particular attention is called since they rarely outcrop in northwestern Ohio.

SECTION ON TEN MILE CREEK.

DEVONIAN

Delaware limestone (*Traverse*).

14. Massive compact bluish drab limestone containing iron pyrites, traces of petroleum and a few fossils.................................. 10′
13. Thin unevenly bedded blue limestone with several layers of white chert, both fossiliferous..... 3′
12. Blue shale and soft shaly limestone containing much iron pyrites and quite fossiliferous.... 2′ 6″
11. Bluish gray limestone alternating with layers of fossiliferous white chert.................... 3′ 6″
10. A rather compact drab limestone with many fossils, occurring as casts, and a considerable amount of fossiliferous white chert.......... 2′
9. Bluish gray shaly limestone with irregular layers of fossiliferous white chert. At places much of this zone becomes a mass of corals....... 2′
8. Rather thick and some thin layers of blue limestone inter-bedded with soft blue shaly layers 4′
7. Covered interval, probably in large part shaly, since a number of rather large pieces were dredged from the bottom of the creek for some distance down stream. It includes the contact of the *Delaware* with the underlying formation................................20′ ±

(2) Report of the Geological Survey of Ohio, vol. 1, pt. 1, p. 576.

Columbus limestone.

6. Very fossiliferous crystalline gray limestone, the upper surface near the highway bridge showing fine glacial striae .... 13′
5. Compact brown limestone in massive beds and containing a few fossils in the upper part... 42′

SILURIAN.

Lucas limestone.

4. Compact drab limestone showing a banded structure. These layers are quite massive but weather into much thinner layers. Several fossiliferous horizons occur near the middle of the zone................................ 63′
3. Compact drab limestone with some dark gray to brown sandy layers. This zone is brobably the basal portion of the *Lucas limestone* rather than a part of the underlying formation.... 36′

Sylvania sandstone

2. A fine grained friable white sandstone becoming coarser and of a conglomeratic nature in the lower part. The extreme base is made up of limestone pebbles imbedded in the sandstone 43′

Tymochtee formation.

1. Rather thin bedded compact drab limestone exposed at the bottom of the sandstone quarry at Silica but better along the creek to the east and south............................ 20′ ±

The line of division between the Silurian and the Devonian is not sharply marked at this place. The change in the character of the depoists from one system to the other is, however, sufficiently great to allow the demarkation of this contact within a few inches or a foot at most. When it is recalled that this is the contact between formations of early or middle Cayugan and upper Ulsterian, it is surprising that the horizon is so ill defined, since it must have been an erosion or weathering surface for a long time. On the Maumee River near Grand Rapids, just across the southern border of Lucas County, the contact is shown and appears as a rather sharp line. Near Columbus, in the central Ohio region, decided evidence of the erosion period which intervened is found in the well developed basal conglomerate of the overlying Columbus limestone.

Along Ten Mile Creek the strata dip to the northwest at an angle which varies frome one to ten degrees. At no place along the creek does the elevation of the strata above drainage exceed eight feet; hence the major part of the section was determined by

measuring the angle of dip at various points, the total width of outcrop, and from this data computing the thickness of the beds. The Delaware, however, was measured more accurately. The Columbus limestone in this section is not essentially different from the same formation as found in other parts of the state. The upper or very fossiliferous portion is perhaps slightly reduced in thickenss and its fauna is somewhat different. This is not so much because of the appearance of new species, but because of the absence of certain characteristic Columbus species, which are so common in central Ohio. The shales and shaly limestones of the Delaware (Traverse), however, present a rather marked contrast to the rock of this formation as it occurs in central or even north central Ohio. In the section under discussion, the fauna is more decidedly Hamilton, there is more shale, and the limestone is even less pure than at localities east of the Cincinnati anticline. A small outcrop of this same shaly limestone occurs along Auglaize River near Junction, Paudling county, where it carries an identical fauna.

There can be no doubt that the Delaware (Traverse) of northwestern Ohio is an integral part of the Hamilton of Michigan and Ontario. It is continuous northward into Monroe county (Michigan) where is has been reported in various well sections[3], and the formation as it occurs farther north, along St. Clair River, is certainly the same. Here it has become much thicker and has lost its cherty layers. At Thedford (Widder) Ontario, this northwestern Delaware fauna occurs in a series of beds[4] which resemble somewhat those that outcrop along Ten Mile Creek.

The following list of species gives some idea of the Devonian fauna in the above section:

TEN MILE CREEK FAUNA.

Species	Columbus	Delaware
Stromatopora granulata Nich		x
Stromatopora ponderosa Nich	x	
Cladopora canadensis Rom		x
Cyathophyllum rugosum H	x	
Cystiphyllum americanum E. and H		x
Diphyphyllum panicum Win		x
Favosites arbuscula H		x
Favosites hamiltoniae H		x
Favosites hemispherica Tr	x	x
Favosites nitella Win		x
Favosites placenta Rom		x
Favosites radiciformis (?) Rom		x
Heliophyllum halli E. and H		x
Streptelasma ungula H		x

(3) Geological Survey of Michigan, vol. VII, pp. 31-33.

(4) Geology of Canada (1863) p. 385.
Also Grabau; Bulletin of the Geological Society of America, vol. XIII, (1902) pp. 150-152.

Species	Columbus	Delaware
Strombodes alpinensis Rom		x
Zaphrentis cornicula (Les.)	x	
Zaphrentis simplex H		x
Dolatocrinus sp		x
Gennaeocrinus (?) *sp*		x
Megistocrinus spinulosis (?) Lyon		x
Cystodictya gilberti (Meek)	x	
Fenestella emaciata (?) H		x
Fistulipora sp		x
Lichenalia sp		x
Orthopora bipinulata (?) (H.)		x
Reteporina striata (?) H		x
Stictoporina plumea (H. and S)		x
Ambocoelia umbonata Con		x
Atrypa reticularis (Linn.)	x	x
Atrypa spinosa H	x	x
Camarotoechia horsfordi H		x
Centronella ovata H		x
Chonetes arcuatus (?) H	x	
Chonetes coronatus (?) (Con.)		x
Chonetes hemisphericus H	x	
Chonetes lepidus H		x
Chonetes mucronata (?) H		x
Chonetes scitula H		x
Chonetes vicinus (Cast)		x
Cryptonella planirostris H		x
Cyrtina hamiltonensis H	x	x
Dalmanella lepida (?) H		x
Eunella lincklaeni H		x
Gypidula sp		x
Leiorhynchus laura (Bill.)		x
Nucleospira concinna H	x	x
Pholidostrophia iowaensis (Ow.)	x	x
Productella spinulicosta H	x	
Rhipidomella vanuxemi H	x	x
Schizophoria striatula Schl		x
Spirifer acuminatus (Con.)	x	
Spirifer audaculus (Con)		x
Spirifer gregarius (Cl.)	x	
Spirifer macrus H	?	x
Spirifer manni H	x	
Spirifer pennatus (Atw.)		x
Spirifer varicosus H	x	
Spirifer sp		x
Stropheodonta concava H		x
Stropheodonta demissa (Con.)	x	x
Stropheodonta hemispherica H	x	
Stropheodonta perplana (Con.)	x	x
Strophonella ampla H	x	
Tropidoleptus carinatus (?) (Con.)		x
Actinopteria boydii H		x
Actinopteria descussata H		x
Aviculopecten sp	x	x
Conocardium cuneus (Con.)	x	
Leioptera dekayi (?) H		x
Limoptera macroptera Con		x
Limoptera pauperata H	x	

SPECIES	Columbus	Delaware
Paracyclas elliptica H	x	
Pterinea flabellum (Con.)	x	x
Bellerophon cf. *pelops* H		x
Callonema cf. *bellatula* (H.)		x
Callanema lichas (?) (H.)	x	
Loxonema hamiltoniae H		x
Pleurotomaria lucina H	x	
Pleurotomaria sulcomarginata (Con.)		x
Pleurotomaria sp		x
Trochonema meekanum Miller	x	
Coleolus tennicinctum (?) H		x
Tentaculites bellulus H		x
Tentaculites scalariformis H	x	
Gomphoceras pingue (?) H		x
Goniatites sp		x
Orthoceras arkenense Whiteaves		x
Orthoceras sp	x	
Phacops cristata H	x	
Phacops rana (Green)		x
Proetus macrocephalus H		x

Several zones were observed, which carry faunules differing from each other, but available specimens were found to be so much more abundant among the loose rock that most of the collection was made from the material thrown on the bank. On account of this manner of collecting, it is impossible to locate the above species in their exact horizons, but Nos. 8 and 9 of the section carry perhaps three-fourths of the species collected from this formation.

The similarity of these northwestern Delaware beds and their fauna to the Hamilton at Thedford, Ontario, rather than to the same formation east in Ohio is certainly remarkable. This is more evident when we study the coral zone [5] and the layers immediately associated with it. Such close relationship doubtless indicates direct shallow water connection between these Ohio and Canadian sections and the center of dispersion of the Traverse-Hamilton fauna, and, on the other hand, indirect connection between northwestern and central Ohio during the time of their deposition.

(5) Grabau; Loc. cit. pp. 152–159.

The University of Chicago.

ON THE CYTOLOGY OF SYNCHYTRIUM.

III. The Role of the Centrosome in the Reconstruction of the Nucleus.*

ROBERT F. GRIGGS.

INTRODUCTORY. The first paper of this series on the cytology of Synchytrium was published by Dr. and Mrs. F. L. Stevens, who took up the study fresh from their remarkable work on the cytology of the Oomycetes, hoping to clear up the very doubtful relationships of the Chytridiales which as they say "have offered an open field for speculation heretofore and have baffled definite judgments as to their relationships." They soon saw, however, that they had a very large problem on their hands because of the many anomalous structures encountered which were very difficult to reconcile with the cytology of the higher organisms. They therefore held the "discussion of these structures for a separate paper, the present one being limited to a series of stages which clearly pertain to true mitosis of the primary nucleus." Other pressing work kept Professor Stevens away from Synchytrium, however, and he decided to turn over his material to the present writer. Some of the structures he saw he has described in a second article ('07). With these suggestions as to the interesting features in the cytology of the group, the writer has been fortunate indeed in having furnished him ready to work with all of Stevens' material, alcoholic, paraffine cakes and slides, as well as notes of observation on the slides. He is therefore under very considerable obligations to Professor Stevens, who, forced to forego the pleasure of working out these structures personally, has yet followed the study with a keen interest which quite justifies the consideration of this as a continuation of his former work on the same object.

Before I took up the material, however, Mr. Lon A. Hawkins, formerly fellow in Botany at the Ohio State University, undertook the investigation but was compelled to drop it on assuming work for the government. It was his preparations that were used in this present work and the writer is very considerably indebted to Mr. Hawkins also for his slides. They are beautiful preparations cut from 2 microns thick and stained in Iron Haematoxylon. Stevens's preparations were stained with the triple stain.

For the rest of the work, Dr. Stevens and I propose to take up in detail, step by step the peculiar cytological structures in this interesting group either separately or jointly as circumstances

* Contributions from the Botanical Laboratorv of the Ohio State University XXXIV.

may favor, with the hope of correlating the cytology of Synchytrium with that of other plants and animals, in a way which may throw some light on some general problems of cell organization and finally to arrive at some conclusions regarding the relationships of the Chytridiales.

Observations.*

After the division of the primary nucleus of *Synchytrium decipiens* which species alone was used in the present investigation, the secondary nuclei divide rapidly without the formation of cell walls till segmentation takes place when there are usually 500–800 nuclei in the cyst. Kusano reports that all these mitoses are similar in *S. puerariae* and such seems to be the case in *S. decipiens*, the only change being in the continual diminution in the size of the nucleus. But while it is believed that all of the mitoses are similar it must be remarked that all of the observations here presented, were made on cysts about midway between the primary cell and the segmented sorus in respect to the number of nuclei, i. e., from cysts with 100–300 nuclei. Whether this has any significance or not we do not at present know.

The spindles of Synchytrium like those of fungi generally, arise within the nucleus and reach metaphase before the nuclear membrane is dissolved from around them. As Stevens found both in the primary mitosis and in the succeeding ones, no centrosomes are demonstrable at the poles. The figure made by the separated chromosomes at each pole in anaphase (fig. 1) resembles greatly that of the same stage in the primary division, compare Stevens's (03) fig. 13 with my fig. 1, thus strengthening the statement that all the mitoses are similar. There appear to be four chromosomes as Stevens supposed though it is sometimes difficult to see more than three (cf. figs. 1, 2, 8. In figure 1 there are four chromosomes at the pole where only three can be seen, one being directly beneath the one shown nearest the nucleolus.)

By the beginning of the telophase the daughter nuclei are separated by an unusually great distance from each other. In the mitoses from which the present figures were drawn they are about 20 microns apart (see figs. 1 and 12.) Such a condition as is shown in figure 5 where the daughter nuclei lie close together is quite unusual. It is readily seen that in thin sections the

* Since the observations herein recorded were made but before they were embodied in their present form Kusano (07) has published a preliminary paper on *Synchytrium puerariae* in which he announces the same relation of the centrosomes to the nuclear membrane as is herein described. Though he gives five figures they are hardly sufficient to demonstrate his point and his fuller paper is to be much desired inasmuch as the action of the centrosomes of Synchytrium are so unusual that confirmation of the results by independent workers will undoubtedly be welcomed by the cytological fraternity.

chances of securing favorable sections of both the daughter nuclei are rather remote. In the present case with sections 2 microns thick, the chance is only about one in twenty-five, neglecting the thickness of the nuclei though they are of about the same thickness as the sections which reduces the chances very materially. It is evident, then, that it is not easy to get a full series of nuclei in which both members of the pair show. Most of the drawings therefore delineate only one nucleus.

While centrosomes are not demonstrable on the spindles at metaphase or early anaphase (fig. 1 cf. Stevens 07 figs. 18–21), in what is interpreted as telophase (fig. 2) there are found enormous asters. The manner of their appearance has not yet been made out Though usually located near the former axis of the spindle they are by no means accurately placed at its poles as can be seen by consulting almost any of the figures. In structure also it may be seen that they vary greatly. Sometimes there is a single deeply staining granule (centrosome proper) at the centre of the radiations (figs. 6, 7, 8, 11); sometimes the deep staining taken at the centre seems to be due simply to the convergence of radiations (fig. 5). In only one case and that not very distinct, was there seen anything approaching a clear centrosphere around the central granule. But very often there is more than one granule The different granules may be located at the focus of a single aster so as to look like a dividing centrosome (fig. 2). They may be scattered about the focus without any very definite relation to the rays(fig. 3). More often the different granules are the centres of separate asters so that there appear two centrosomes (fig. 2, 4). Rarely there may be more than two distinct centrosomes; figure 9 shows a case where there were three connected by heavy fibrous bands of kinoplasm, while each has its own aster. Figure 10 shows an anomalous condition where the centrosomes are located at nearly opposite poles of the nucleus while their rays meet so as to extraordinarily resemble the amphiaster common in animal mitosis. Judged by itself this nucleus would seem to be in the prophase of division for in addition to the amphiaster the chromatin is arranged similarly to the spirem of the prophase. Such an interpretation seems, however, entirely inadmissible, since the chromatin in prophase does not, so far as is now known, assume such a spirem and the spindle, being intranuclear, has no relation to any such amphiaster. This condition was seen only in the single nucleus located in a cyst where all the other asters conform to the usual type. Fig. 7, however, shows a condition interesting in comparison; though this may be simply a case where the second nucleus of a pair was cut out of the section, leaving a part of its aster. Here, in addition to the conspicuous aster at one pole of the nucleus, is another on the opposite side which though faint and lacking a very definite

granule is still clearly visible showing in addition to a few short rays stretching away from the nucleus others connecting with the nuclear membrane.

The various irregularities in the centrosomes are to be compared in the judgment of the writer, to those present in the formation of centrosomes de novo, under more or less abnormal chemical stimulation, in animals. In many of these cases there are formed a multitude of small asters two of which grow large and form the amphiaster. Because of the difficulty of determining the sequence of events, having no other indications of the relative ages beside the condition of the asters themselves, it cannot be asserted that the different asters coalesce or that one of them gains the mastery while the other disintegrates. Nevertheless it is to be noted that without exception those asters which are interpreted as the end stages were, so far as seen, uniformly single (figs. 12-14).

The activities of the centrosomes and of the chromatin in the reconstruction of the nucleus are apparently independent of each other to a considerable degree so that it seems necessary to consider them separately. In the telophase the four chromosomes lie loosely in the cytoplasm making a figure not unlike the typical daughter star. They have a manifest tendency to converge to the centrosome which is more clearly shown in cases where there are two asters, when part of the chromosomes may follow the rays of each. At the distal ends of the chromosomes, with respect ot the aster, there soon appears, in connection with one or more of them (fig. 2) a thickening which enlarges at the expense of the chromosomes till it becomes the karyosome (nucleolus) of the resting nucleus (fig. 2). The transfer of the chromatin to the karyosome consists apparently, not so much in the direct absorption of the chromosomes as in the gradual removal of the chromatin from the linin matrix so that in many cases the ends of the chromosomes farthest away from the karyosome become vacuolate, as it were, and lose their staining reaction giving a gradual transition from one condition to the other thereby showing apparently that the chromatin migrates granule by granule from the linin matrix (fig. 2.) Those chromosomes which do not directly connect with the growing karyosome form linin bridges across to it, by which the chromatin may be transferred.

In many cases the nuclear membrane is formed before this process is complete and there results a spirem which closely resembles that usually found in the prophase of dividing cells. (figs. 7-11). In such spirems all resemblance to the original chromosomes may be lost and a loose, few-meshed network formed. In as much as the conduct of the chromatin and of the asters are independent, some doubt is thrown on the exact sequence of the transformations of the nucleus as well as of the cen-

trosomes. This is particularly true of the stage represented by fig. 14, where the chromatin is in spirem in every one of the nuclei in the three cysts observed although the aster has apparently run its course. This suggests that we have not reached a full understanding of the phenomena as yet. Nevertheless in any case it seems certain that the resting nucleus, with its chromatin all or nearly all concentrated in the single globular karyosome (figs. 12–13) must be connected with the chromosomes of anaphase by a series of stages not far divergent from these here described.

The cycle of astral activity which is the main interest of the present paper may now be taken up. When at their maximum size the rays are relatively few, long, and so thick as to be clearly visible under a low magnification. They are not always straight (fig. 7) and do not always center exactly in the focus of the aster (fig. 12). Quite often they have thickenings or granules along their length (figs. 2, 4, 5, 12). These are apt to be located at the intersections of the rays with the strands of the cytoreticulum (fig. 5). At later stages the central deep staining granule gives place to a larger diffuse granular area in which there may be still some deeper staining granules but they are more minute than those which preceeded them. The rays at the same time become finer and more numerous till they resemble the spindle fibres in ordinary mitosis. The granular area then appears to enlarge while the rays disappear and finally the centrosome seems to become simply a densely granular mass of cytoplasm which does not stain more deeply than the general reticulum (fig. 14). In this stage the centrosome resembles greatly the so-called attraction spheres of some animal cells, e. g., some stages of Ascaris. This mass is then dissipated into the general cytoplasm by imperceptable stages thus leaving the nucleus without centrosomes as it began. As before indicated the condition of the nucleus at this time throws some doubt upon this sequence so that the history of the centrosome, like that of the nucleus, may be subject to some revision. But it appears sure that the centrosome arises de novo out of the cytoplasm and disintegrates into cytoplasm again whether the sequence of events be exactly that given or not.

The remarkable feature of the aster, however, is the relation of the rays of the centrosome to the reconstruction of the nucleus. At an early stage a vacuole appears around the chromosomes. This is at first quite without a membrane (fig. 2) but very soon those astral rays which are nearby come to form a cone enclosing it (figs. 3, 4). Soon the ends of the rays bend around the vacuole and enclose it *forming the nuclear membrane* (figs. 5, 6, 7). These membrane-forming rays may be observed to taper greatly from the center toward the curved ends (figs. 4, 7). At their thicker ends they are very heavy indeed and stain deeply so that they

could not be accurately represented by anything less than the heavy lines in the drawing. Since the rays are cylindrical rods rather than plates the membrane is not a first any membrane at all but a cage around the vacuole. The method by which the interstices between the bars are filled up could not be followed satisfactorily. But it may be that the substance of the rays gradually spreads out around the vacuole till the membrane is completely formed. This process may be seen on the side of the nucleus towards the centrosome in those cases where the apex of the cone of rays is very acute. Here the rounded surface of the vacuole may be seen to acquire a membrane like that of the rest of the nucleus so gradually that it is often difficult to tell whether the membrane is present or absent (fig. 11) In these cases the cap of rays persists for a considerable time but gradually fades when the membrane is complete (figs. 10, 11).

This method of the formation of the nuclear membrane by the rays of the centrosome has been observed by the writer in very many cases; to the five figures given to illustrate the stages of the process could be added many more if it were deemed necessary.

Aside from the peculiar method of its formation, the nuclear membrane of Synchytrium is a remarkable structure. In the primary nucleus it reaches a relatively enormous thickness (See Stevens '03, fig. 5) and it is so stiff that it is often broken and carried away by the knife. In the succeeding mitoses it is not only thickened but sometimes presents some very peculiar aspects which we shall hope to deal with in a later paper. One feature may be touched upon here.

Those rays which form the membrane, like the others, frequently have granules strung along them In other rays the granules are centrally placed on the ray but in these they are nearly always found on the *inside* of the nuclear cavity (figs 4, 7, 8). In older stages they may be found either within the nucleus, in the wall, or lying against its outer edge (fig. 12). Perhaps, correlated with these granules are others frequently seen loose in the cytoplasm, and surrounded each by a vacuole of its own (fig. 11). But consideration of these would carry us too far afield. We can not do more at this time than to suggest the possible analogy between the formation of these granules and the derivation of the microsomes of the cytoplasm from the nucleus as described by Lillie and others.

SUMMARY. The exact history of the structures touched incidentally, the asters and the chromatin content of the nucleus, is somewhat provisional, but the point of the present paper is the demonstration, confirming and amplifying Kusano's announcement that the rays of the centrosome enclose the vacuole surrounding the naked chromosomes, and form a very heavy deeply staining membrane around it, the nuclear membrane.

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EXPLANATION OF PLATES XIX AND XX.

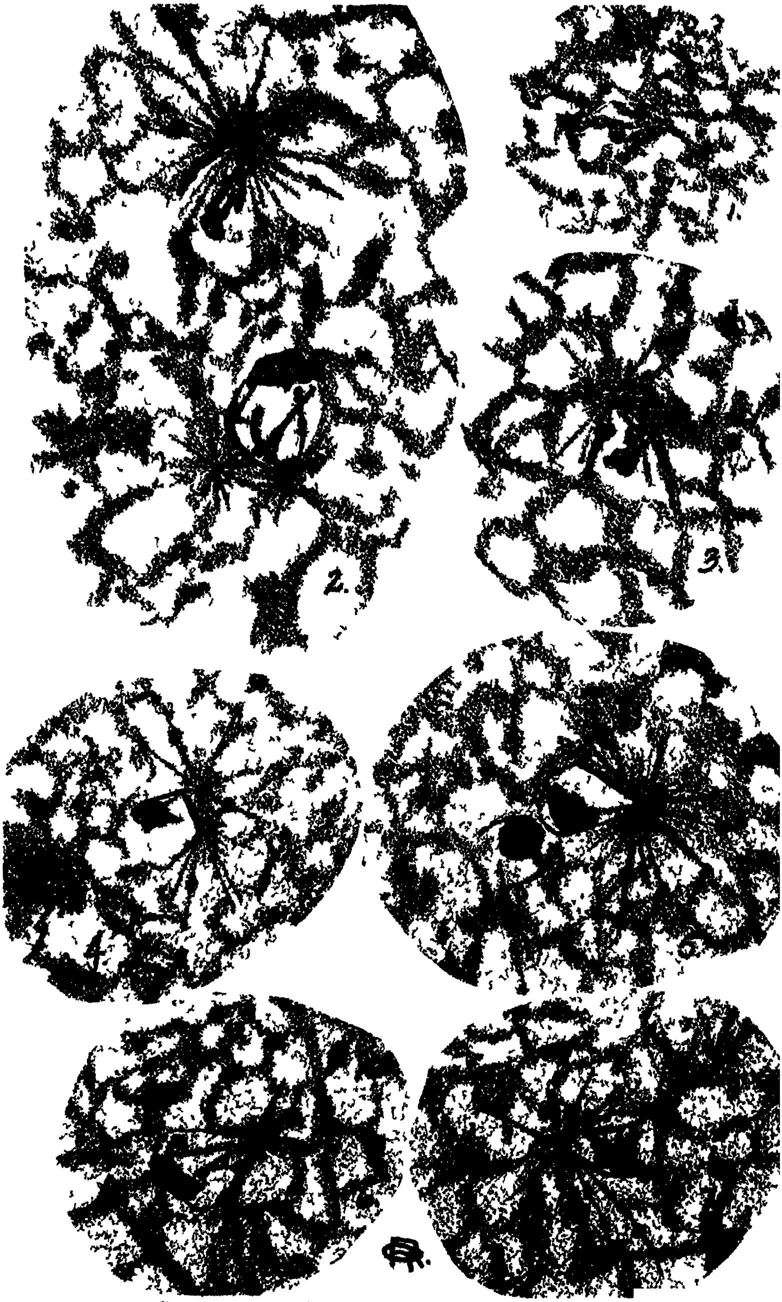
The figures were made with a Spencer 1.5 mm achromatic, oil immersion objective and a Zeis compensating ocular 12 giving at the table a measured magnification of approximately 4000 diameters. They were reduced to 2-3 of their original size exactly canceling the enlargement due to the camera and rendering the figures the same size as they were seen in the field of the microscope, namely enlarged 2670 times. All are camera drawings.

Fig. 1. Early anaphase; a blob of chromatin at one pole, at the other 4 chromosomes, one covering another.

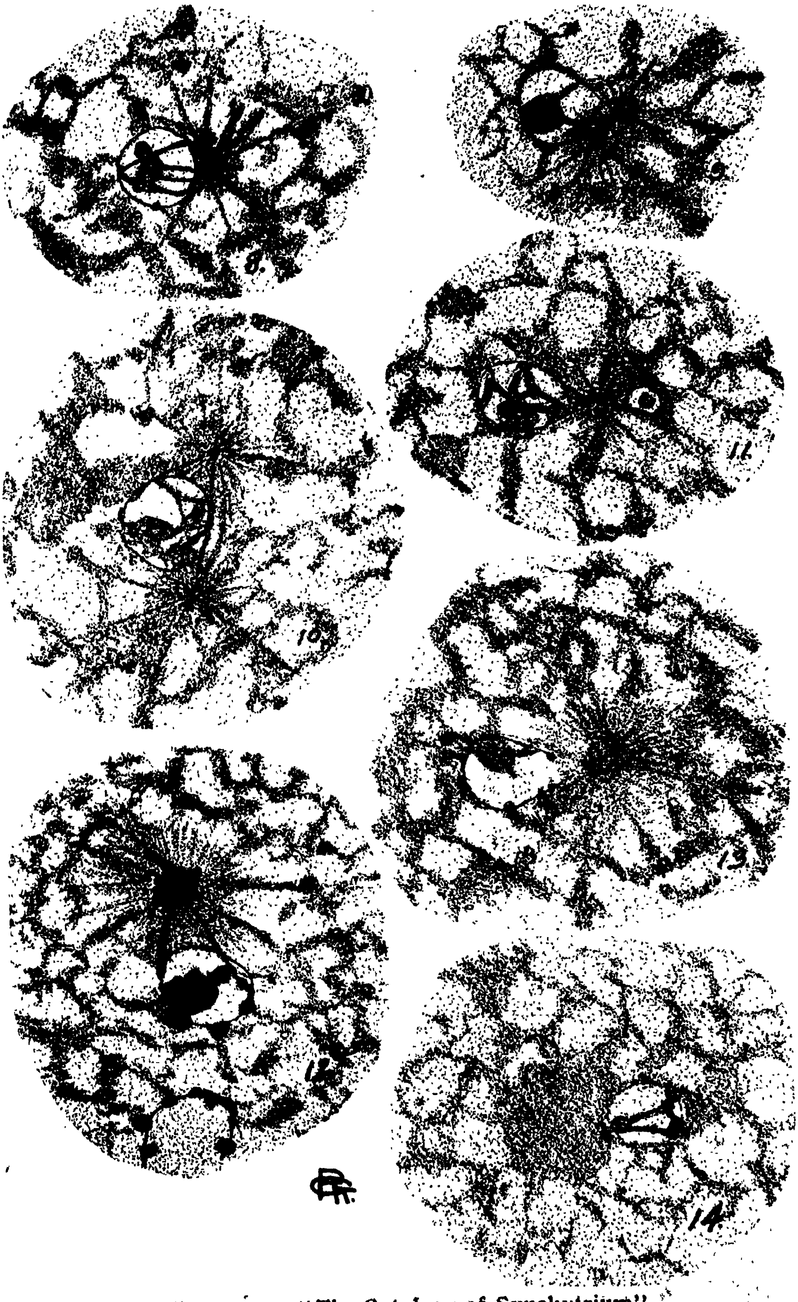
Fig. 2. Telophase considerably later than fig. 1.Showing the process of transformation of the chromosomes and also the beginning of the nuclear vacuole which is without a membrane.

Fig. 3. Nucleus in wich the rays are beginning to be associated with the edges of the nuclear vacuole.

Fig. 4. Nucleus with two asters the rays of each of which are beginning to form the nuclear membrane.



GRIGGS on "The Cytology of Synchytrium"



GRIGGS on "The Cytology of Synchytrium"

Fig. 5. A pair of daughter nuclei remaining unusually close together (one cut in sectioning); rays of the centrosome prominent and granular, bending around the nuclear vacuole on the side opposite the centrosome, but not yet met to complete the membrane.

Fig. 6. A cone of tapering astral rays enfolding the nuclear cavity and bending around beyond it; prominent granules on the nuclear membrane.

Fig. 7. Muclear membrane almost complete by the meeting of the rays

Fig. 8 Nucleus showing a banded condition similar to a spirem; the bands probably derived from the four chromosomes

Fig 9 A nucleus with three distinct asters connected by heavy radiations.

Fig. 10. A nucleus in a spirem-like condition with two centrosomes forming, with their radiations, a figure like an amphiaster.

Fig. 11. A nucleus showing the gradual genesis of the nuclear wall on the side next the centrosome, also a large deep-staining granule surrounded by a vacuole.

Fig. 12 An aster with a large rather diffuse centre and numerous very fine rays, nuclear membrane complete but still associated with the rays. On the membrane of both this and the portion of the sister nucleus are conspicuous granules lying in different positions with respect to the nuclear wall.

Fig 13. Centrosome more diffuse than in fig. 12· nuclear membrane disturbed by knife.

Fig 14 Nucleus in spirem sage with a large mass of dense cytoplasm at one side which is interpreted as the end stage of the centrosome

Just as this number goes to press telegrams bring the sad intelligence of the death of Professor W. A. Kellerman in Guatemala. Professor Kellerman was one of the most active in the founding of the NATURALIST, a member of its advisory board since the beginning, and its volumes include a large number of contributions from his facile pen. He was a most enthusiastic and untiring worker and the rich collections which he has brought together, representing the flora of home and foreign countries will be a permanent evidence of his devotion to science.

Only meager information concerning his illness is at hand, but we learn that interment will be made in Guatemala, in the region which has been the scene of his latest work and which he had explored with a delight born of love for its beauty of scenery and wealth of life.

We must reserve for a later number fuller details, and the appreciations merited by his work. H. O.

TWO NOTABLE LANDSLIDES.*

GEORGE D. HUBBARD.

The landslide is the sort of phenomenon to have caught the attention of the geologist of a century ago, but with our present substantial grounding in uniformitarianism, and in our attempt to appreciate duly the ordinary, we are more than likely to underestimate the importance of the extraordinary. Hence, I want to call attention to this rather remarkable, and, in some localities, prevalent, process of denudation.

In many of the newer valleys of southeastern Ohio, land slide topography is almost omnipresent. Hundreds of acres of land along the steeper valley walls have been ruined or badly damaged for agriculture by slipping, and tumbling down the slopes, or by being covered with material which has tumbled down. The sliding usually so mixes the soil with the subsoil, or that part of the regolith yet unprepared for supporting plant growth, that the soil can no longer be used. Further, the tumbled, bunchy condition of a landslide prevents cultivation and harvesting, and even hurts the area seriously for pasture.

Within historic time, there have been thousands of landslides of various sizes in the hilly part of this state, and many occur every year even down to the present time. In the aggregate they must be rather important physiographic phenomena. During the past sixteen months a considerable number of minor, fresh heaps of tumbled debris have been examined, and two very extensive piles have been studied.

The first notable landslide studied in Ohio occurred in the spring of 1906, near the training track of a Mr. Corwine, about two miles up the Scioto from Waverly. The upper (Pre-Wisconsin) outwash terraces are here very extensively developed, and well preserved. Going northward or northwestward across the level upper terrace-top past the training track, one approaches a place where an area comprising many acres of the terrace has gone down 1–25 feet and slipped forward toward the stream carrying fine rich pasture and scattered, old oaks down with it. The slip has the appearance of recency. The section through the outwash here is, from the top downward, washed gravel and sand with much fine, poorly-sorted, material, 25–30 feet; then blue clays and fine sands ideally stratified and containing, occasionally, strata of brown iron-stained sand, or layers bearing black sand of garnets, magnetite and some more valuable metallic oxides. This fine clay and sand attains an exposed thickness

* By permission of the State Geologist of Ohio. Read at the meeting of the Ohio State Academy of Science, 1907.

of 25–40 feet and may be underlain by micaceous sand behaving like quicksand, although no true quicksand could be located except a seam in a well, up on the terrace at a depth of 20–30 feet and at a distance from the landslide of more than a half mile.

The landslide began by the falling of the front of a steep bluff of this outwash material after it had been undermined by the stream (a branch of the Scioto from the west). This was followed by the settling down of 10–15 acres of the adjacent terrace land, and the horizontal layers of blue clay and sand exposed in the stream bed for a generation were made to buckle and fold as if pushed up from below or crushed laterally, and then forced forward into sharp folds. This stratified clay, turned up vertically, rose across the valley obstructing the channel and effectively ponding the waters back. A lake a fourth mile long was formed, whose overflow is slowly cutting an outlet notch through the vertical layers of tough clay.

Such a slide could hardly have occurred unless there had been a yielding stratum below in which slipping could take place, hence the supposition of quicksands, or micaceous layers at least, beneath the surface.

The more remarkable physiographic effects of this slide are (1) the lowering and tumbling of an area of level pasture and scattered timber several acres in extent, through a vertical distance of one to twenty-five feet; (2) the folding and pushing up of a series of horizontal clay layers; (3) the ponding back, by the latter phenomenon, of the waters, and the production of a temporary lake; (4) the complete closing of a large spring and its re-formation in a new place several rods distant and a few feet higher.

The second large landslide occurred many years ago. It lies in and rather completely closes the valley between the head of Cranenest Fork of Little Muskingum and a short branch of Oppossum Creek about one and one-half miles west of Winkler's Mill, Monroe county, Ohio The topography of the vicinity is shown on the New Martinsville and New Metamoras sheets of the United States Geological Survey topographic map.

At the point indicated, the divide is about 1110 feet above sea level, but has the appearance of a low col in a valley whose walls rise over one hundred and fifty feet above the crest of the col. The material of this divide is loose rock waste with a bunchy surface considerably subdued by subaerial agencies and deeply gashed by headward erosion. On the east side of this divide the little branch of Oppossum Creek falls 100 feet in one-fourth mile and another hundred in less than a full mile. This branch is on rock back to the landslide. Cranenest Fork, flowing N. W., falls 100 feet in about one mile and another hundred feet in about

2½ miles. It is not on rock until more than one half mile from the landslide. Westward along this creek a distance of seven to eight miles, or, about to the crossroads called Cranenest, the tributaries all enter the main creek barbed, as if the latter had been reversed since their courses were established. The altitude of the bed of the stream here is only 830 feet above sea level a depth reached by Oppossum Creek about two and one-half miles from the divide. The fact that the streams are on rock so near the divide does not prove that the valley floor here before the landslide was no lower than the bed rock now exposed. It suggests that the landslide and accompanying or ensuing aggradation covered the old rock floor, in such manner that, subsequent erosion was not directed along the line of the previous axis of the valley; but that the streams, cutting through the mantle rock where they found themselves, have in places, encountered rock at much higher levels.

The physiographic effects of this landslide seem to have been (1) the plugging of a valley several miles below the divide to such an extent that (2) the waters of a southeast flowing stream leading to Oppossum Creek were ponded back and made to rise in a lake and flow over the divide into a branch of Little Muskingum now called Cranenest Fork, and thereby (3) the course of a stream for seven or eight miles was reversed, and this much of one creek was removed from its head and added to the head of another. Since the reversal, the col-divide, over which the waters were forced, has been cut down, and the stream now flows out westward by an easy grade; while to the eastward, the short stream, tributary to Oppossum creek, and thereby, to the Ohio, is rapidly endeavoring to push its headwaters back and recover its lost territory.

OCCURRENCE OF TYPHLOPSYLLA OCTACTANUS IN OHIO.

HERBERT OSBORN.

While many species of fleas are recorded for different mammals in America, there have been so far no definite records of the occurrence of any of these parasites upon bats. A number of species are known in the old world as infesting these mammals, and it has been a matter of some interest here to determine whether our native species of bats were infested by the same or similar species. In July, 1906, I found upon a bat taken at Cedar Point several specimens of a flea which undoubtedly belongs to this genus and which in its main characters agrees closely with the European species named above. There are some points of difference as compared with a description of that species, especially in the number and arrangement of tenidia, but

these seem scarcely sufficient to warrant the separation of the species, at least without more exact knowledge as to the limit of variation in this characteristic than I have at the present time. The parasite must be quite rare as I have frequently secured other forms of parasites from bats, and would certainly have noted these if they, had been common. Since the title of this paper was forwarded I have receievd a paper from Professor A. M. Banta on the fauna of Mayfield Cave in which he mentions the occurrence of fleas in connection with the bats of that cave, but he does not refer them to any particular genus or species Doubtless they belong to this genus and their specific determination would be a matter of interest

Note on the American Barn Owl.

JAMES S HINE.

The barn owl appears to be a rather common bird on the Ohio State University grounds, but on account of its nocturnal habits and quiet disposition it is not often seen Several specimens have been sent in from different parts of the state, indicating that the species is at home in other sections besides Columbus

Last fall, near the first of November it was observed that a nest of the barn owl was located in a cavity in one of the large sycamores in the field near the Biological Building. During the early part of each night the young birds made a great deal of noise, in their way, about the nest and the old ones were seen occasionally leaving and returning. About the 10th of the same month two of the young were observed on the ground near the nesting tree, but, although they were quite well feathered they could not fly sufficiently well to get back into the nest and so lost their lives. The flight feathers were well out and the birds were just at the stage when they gave a fine exhibition of the pushing out of the nest down by the more substantial body covering.

The season of nesting is one of the more interesting points in the matter, and if we consider Audubon's calculations as a guide the eggs must have been deposited sometime in August, perhaps near the middle of that month. As practically all of our birds are through nesting at this season, it is difficult to arrive at the point of considering this the regular nesting time of the species in question in this section. There is in the museum of the university a set of eggs of the barn owl labelled Santa Paula, California, March 27th.

Some of the students and myself in looking over the ground beneath the tree, picked up a number of the cast-up pellets which contained many jaw bones of the common meadow mouse and so far as we could judge this mammal furnished much of the food of the owls.

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AN ECOLOGICAL CLASSIFICATION OF THE VEGETATION OF CEDAR POINT.

BY OTTO E JENNINGS

The peninsula of Cedar Point, forming for seven miles a narrow barrier between the marshes and open waters of Sandusky Bay on the west and Lake Erie on the east, is probably by far the best place in Ohio for the study of ecology, either with respect to the adaptation of the plants to their environment, or to the aggregation of different species of plants into associations of various kinds, or the successional development of these various associations.

During the summer months of 1903 the writer, acting in capacity of Assistant to Dr. W. A. Kellerman, devoted his entire time to the preparation of a herbarium of the flora of Cedar Point and, in 1905, while acting as Instructor at the Lake Laboratory, the peninsula was again thoroughly explored and considerable study was made of the ecological phases of the subject. In 1906 and again in 1907 several days were spent on the peninsula, mainly in taking notes and in perfecting previous classifications of the vegetation, and it is believed that a fairly correct general ecological classification can now be presented of the vegetation of Cedar Point.[1]

This rather brief *reconnaissance* is given in the hope that it may be of use to other students of the flora of Cedar Point, serving as a basis for future more detailed and comprehensive work along ecological lines. Excellent opportunities are presented at Cedar Point for exact instrumental studies of the various habitats and it is to be hoped that the future may see this accomplished.

1. The author would here take the opportunity of gratefully acknowledging the various courtesies extended to him by Prof. Herbert Osborn, Director of the Ohio State University Lake Laboratory, and also the assistance rendered by Mrs. O. E. Jennings in the preparation of the illustrations for this article.

The shores of ponds, lakes, and oceans have been the subject of ecological studies to a greater extent than has any other physiographic region. This is, no doubt, due to the concentration in a small space of many different plant formations with the developmental stages exceptionally well defined. Studies of this sort of particular interest with respect to the ecology of Cedar Point, being physiographically quite similar as to the areas embraced, are those of MacMillan at the Lake of the Woods,[2] Cowles at the southern end of Lake Michigan,[3] Ganong at the Miscou Beach,[4] and Kearney at the Great Dismal Swamp,[5] and at Ocracoke Island.[6]

As referred to in the present article an association of species occupying a definite, more or less homogeneous unit of ecological environment (habitat), is termed an ecological plant *formation* The formation is the unit of vegetation and is always characterized by one or more dominant species which are termed the *facies*. The facies may appear separately from each other, each having a definite association of accompanying species, and where this happens the facies thus characterize as many different *consocies* Certain species in the formation may become very conspicuous at certain periods in the season (*aspects*), such species being termed *principal species* and the associations which they thus characterize, *societies*. The aggregation of the common descendants of a plant constitutes an ecological *family* and the aggregation of several families an ecological *community*.

All plant formations bring about reactions of various kinds in the habitat,—removal of plant foods, accumulation of vegetable debris, cutting off the light, etc.,—which usually result in making the habitat less suitable to the resident species but better suited to other species which, by *invasion* of the altered habitat, may eventually occupy it to the complete exclusion of the species of the original formation. Invasion consists (first) of *migration*, by which is meant the entrance into the habitat of disseminules of various sorts (seeds, spores, vegetative shoots, etc.), and (second) of *ecesis*, by which is meant the germination, growth, and establishment of the migrant disseminule.

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2. MacMillan, Conway. Observations on the Distribution of Plants along Shore of Lake of the Woods. Minnesota Botanical Studies. Geol and Nat. Hist Survey Minn. Bulletin 9 : 949-1023. 1897.

3. Cowles, H. C. The Ecological Relations of the Vegetation of the Sand Dunes of Lake Michigan. Bot. Gaz 27 : 95-117, 167-202, 281-303, and 361-391. Feb., Mar., Apr., and May, 1899.

Also the Physiographic Ecology of Chicago and Vicinity. Bot Gaz. 31 : 73-108, 145-182. Feb. and Mar, 1901.

4. Ganong, W. F. The Nascent Forest of the Miscou Beach Plain. Bot. Gaz. 42 : 85-87. 1906.

5. Kearney, T. H. A Report on a Botanical Survey of the Dismal Swamp Region. Contr. Nat. Herb. 5 : 367-395. 1901.

6. Kearney, T. H. The Plant Covering of Ocracoke Island. Contr. Nat. Herb. 5 : 275-284. 1900.

With the appearance of a new habitat, such as the elevation of a new land area, the initial formations will be *open*, i. e., not occupying the whole area; but, with successive changes in the habitat, often determined largely by reactions caused by the vegetation itself, the formations will become *closed*, and *competition* between the various species may become severe. From the *initial stages* the vegetation of a habitat will thus normally pass through a varying number of *intermediate stages* to an *ultimate* or *climax stage* in which the vegetation has reached a more or less permanent condition, termed *stabilization*.[7] Recent investigations have added considerably to our knowledge regarding competition between various species of plants and this has an important bearing upon the subject of succession between the various formations. It has been found that many plants throw off, or at least cause to be present in the soil certain substances toxic to themselves, to certain other plants, or to both.[8] Such phenomena alone could account for many ecological successions.

The ecological classification of the vegetation of a region is usually very intimately correlated with the physiography of that region, and the development of the vegetation through the successive stages of a succession is very often definitely determined by the corresponding land forms occurring in the physiographic development of the region. To this statement Cedar Point is no exception and the excellent work of Moseley in tracing the physiographic development of Cedar Point and Sandusky Bay is of great service to the student of the ecology of this region, in affording a foundation upon which to base an ecological classification of the vegetation. As a matter of fact, Prof. Moseley's publication includes much botanical matter directly in the line of an ecological classification, especially with reference to the vegetation of the sand ridges of the peninsula.[9]

The writer's extended investigations of the ecology of the peninsula of Presque Isle at Erie, Pennsylvania, during the last three years, and now in the course of publication, has led to a much better understanding of certain vegetational phenomena on Cedar Point Presque Isle is considerably larger than Cedar

7 For an extended discussion of the various ecological processes and vegetational structures the reader is referred to Research Methods in Ecology, by F E Clements, Lincoln, Nebraska 1905. In the present contribution the writer has followed Clements' terminology so far as technical terms have been used.

8. Livingston, B E, Britton, J. C., and Reid, F. R. Studies on Properties of Unproductive Soils. U. S. Dept. Agr., Bureau of Soils, Bull 28 : 1–39. 1905. Also Livingston, B. E, assisted by Jensen, C. A., Breazeale, J. F, Pember, F. R., and Skinner, J J. Further Studies on the Properties of Unproductive Soils. U. S. Dept. Agr., Bureau of Soils, Bull. 36 : 1–71. 1907.

9. Moseley, E L. Formation of Sandusky Bay and Cedar Point. Proc. Ohio State Acad. Science. Thirteenth Ann. Rpt. 4 . 179–238. June 15, 1905.

Point, the vegetation is almost entirely in its natural state, free from human interference, and some of the successions present a remarkably complete series of stages, whereas Cedar Point presents, in many cases, a fragmentary series considerably disturbed by man's activities.

With this explanation the writer in this contribution may, perhaps, be pardoned for frequent comparative references to the vegetation of Presque Isle. Although often differing considerably as to particulars, Presque Isle and Cedar Point have much in common, both with reference to the general physiographic development of the peninsulas and to the ecological classification of their vegetation.

The best method of treatment of the structure of the vegetation of any particular locality is, to be sure, more or less dependent upon the completeness of the successions. If the various stages of the successions are present it is most logical to use the developmental method, taking up the various stages in the order of their development and considering the vegetation as a gradual growth or evolution from the simple initial stages to the more complex stages tending towards stabilization.

The vegetation of Cedar Point will be discussed in this paper according to the developmental method, as many of the successional stages are exemplified, or at least indicated, in the present vegetation, while correlations with certain similar structures on Presque Isle will indicate the probable composition of certain missing stages.

The following classification is here presented as a provisional outline of the vegetational structures on Cedar Point. Wherever the same structure has been recognized both here and on Presque Isle the same nomenclature has been adopted as was used in the author's forthcoming work on the ecology of Presque Isle.

A—The Cottonwood Bar-Ridge-Thicket-Forest Succession.
- a—The *Populus-Salix* Dune Formation,
- b—The *Andropogon* Dune Formation,
- c—The *Toxicodendron* Thicket Formation,
- d—The *Pinus-Juniperus* Forest Formation,
- e—The *Quercus velutina-imbricaria* Forest Formation,
- f—The *Ulmus-Acer* Forest Formation.

B—The Lagoon-Marsh-Wet Meadow-Thicket-Forest Succession.
- a—The *Potamogeton* Formation, and
The *Populus-Salix* Formation.
- b—The *Potamogeton* Formation, and
The *Juncus-Eleocharis* Formation, and
The *Populus-Salix* Formation.
- c—The *Potamogeton* Formation, and
The *Typha-Scirpus* Formation, and
The *Salix spp.* Formation, and
The *Populus-Salix* Formation.

d—The *Potamogeton* Formation, and
The *Castalia-Nymphaea* Formation, and
The *Decodon-Persicaria* Formation, and
The *Cephalanthus-Cornus* Formation, and
The *Rhus-hirta* Formation, and
The *Ulmus-Acer* Forest Formation.

C—The Beach-Sand Plain-Thicket-Forest Succession.
a—The Lower Beach...The *Chlamydomonas* Formation,
b—The Drift Beach.....The *Cakile-Xanthium* Formation,
c—The Sand Plain ....The *Artemisia-Panicum* Formation,
d—The *Rhus-Prunus-Toxicodendron* Thicket Formation,
e—The *Quercus velutina-imbricaria* Forest Formation.

D—The Beach-Sand Plain-Heath-Forest Succession.
a—The Lower Beach...The *Chlamydomonas* Formation,
b—The Drift Beach.....The *Cakile-Xanthium* Formation,
c—The Sand Plain........The *Artemisia-Panicum* Formation,
d—The Heath.........The *Arctostaphylos-Juniperus* Heath Formation,
e—The *Quercus velutina-imbricaria* Forest Formation.

E—The Dune and Blowout Successions.
a—The *Ammophila* Fringing-Dune Formation,
b—The *Elymus Dune* Formation, or
The *Andropogon* Dune Formation,
c—The *Prunus-Rhus* Dune Thicket Formation, or
The *Arctostaphylos-Juniperus* Heath Formation.

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a—The *Artemisia-Panicum* Blowout Formation,
b—The *Arctostaphylos–Juniperus* Heath Formation.
(The Secondary *Catalpa* Blowout Formation).

F.—The Bay-Marsh-Wet Meadow-Thicket-Forest Succession.

A. The Beach Habitat.

a—Same as under the Beach-Sand Plain-Thicket-Forest Succession.

B. The Marsh Habitat.

a—The *Scirpus* Formation,
b—The *Phragmites-Typha* Marsh Formation,
c—The *Salix discolor-lucida* Thicket Formation, or
The *Calamagrostis canadensis* Wet Meadow Formation,
d—The *Rhus hirta* Thicket Formation,
e—The *Ulmus-Acer* Forest Formation.

C. The Cove Habitat.

a— (The *Chara* Formation),
b—The *Potamogeton* Formation,
c—The *Castalia-Nymphaea* Formation,
d—The *Phragmites-Typha* Marsh Formation,
e—The *Calamagrostis canadensis* Wet Meadow Formation,

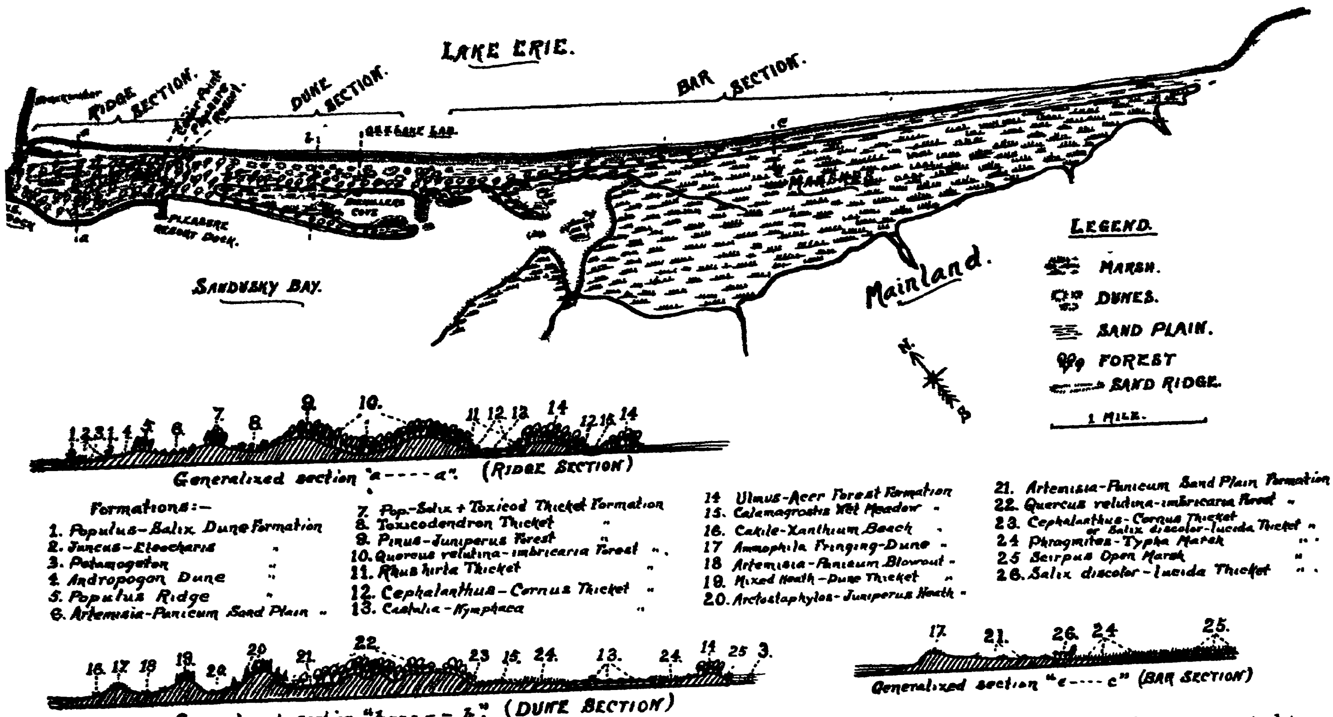

FIG. 1. Generalized ecological map and transects of Cedar Point The width of the peninsula is relatively exaggerated to better show the vegetational features, and the finer topographic features are only approximately correct. For more accurate details of topography see Moseley's contribution and the U S. Geolo. Survey Topographic Map.

f—The *Cephalanthus-Cornus* Thicket Formation,
g—The *Rhus hirta* Thicket Formation,
h—The *Ulmus-Acer* Forest Formation.
(The Anomalous *Ailanthus* Forest Formation).

THE COTTONWOOD BAR-RIDGE-THICKET-FOREST SUCCESSION.

As Prof. Moseley has so well shown, the terminal portion of Cedar Point, termed the Ridge Section, consists mainly of a series of sand ridges initiated by northeast gales during times of high water in Lake Erie, and subsequently built up to their present dimensions by the combined action of wind and vegetation in accumulating the loose beach sand. The approximate dates of formation of the ridges are shown to run consecutively from about 1429 A. D. for the oldest ridge, on the Bay side of the peninsula, to 1899 for the youngest ridge along the Lake front.

Beginning, therefore, with the present Lake Erie beach of the Ridge Section, the vegetation may be discussed from the developmental standpoint from the youngest to the older stages of the succession, the various stages being found in connection with similar physiographic units (sand ridges and intervening depressions) of consecutively older formation.

During a northeast gale, with high water in the Lake, the loose beach sand may be piled up into a bar which, upon the subsidence of the waves, will be left more or less permanently above the ordinary water level. Behind this bar there will be a more or less completely segregated lagoon. Into such a beach lagoon there will be blown during late spring many willow and cottonwood disseminules, which, floating upon the surface of the water, will soon be deposited and buried in the loose, wet sand which rapidly accumulates around the banks of the newly formed lagoon. Here the disseminules will sprout and the lagoon will soon be bordered by a zone of little cottonwoods and willows. The lagoon may be so narrow as to be completely filled up by the drifting sand before other vegetation may be able to establish itself, or, if the lagoon be wider, other vegetation may become established only to be later buried under the sand and killed. In either case, however, a sand rigde has been initiated by the establishment of the zone of cottonwoods and willows.

With the growth of the cottonwoods and willows there is offered an obstruction to the drifting sand, the height of the obstruction by its continued vertical growth tending to build the ridge ever higher. Cottonwoods will continue to grow vigorously under such conditions, providing the tops of the plants are not entirely buried. On Presque Isle the writer found cottonwoods buried to a depth of nearly 30 feet and still vigorously growing. As the lower branches of the tree become buried in the sand they die, although for a long time serving the purpose

of sand binders, and numerous roots are sent out from all portions of the buried trunk.

The initial stage of the succession under discussion may be designated as follows:

The *Populus-Salix* Dune Formation.

Facies: *Populus deltoides*,
Salix cordata (?).

Secondary Species:
Cakile edentula, *Salix interior*,
Ammophila edentula.

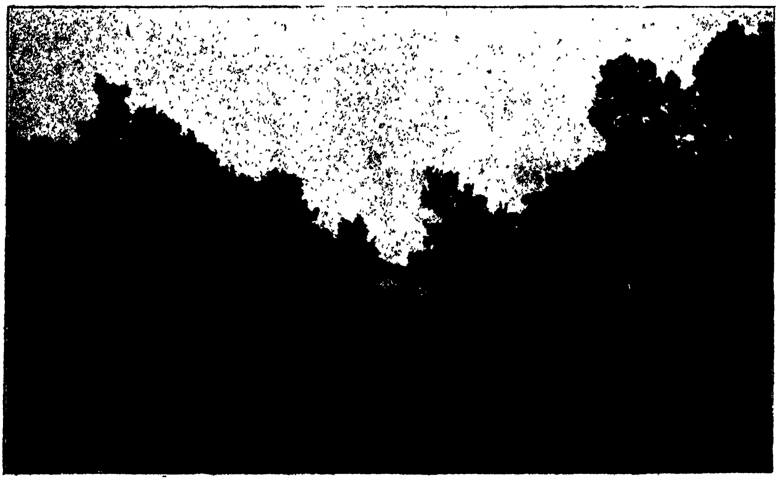

FIG. 2. Looking southward along the west side of sand ridge between the summer cottages and Lake Erie, north of the Breakers Hotel. Note the *Populus* forming the backbone of the ridge and the *Ammophila* and *Salix* being rapidly buried.

The rapidly growing ridge along the Lake front north of the Breakers Hotel is a fine example of the young stage of this formation. (Ridge No. 8, Moseley). With the vertical growth of the ridge the willows are soon buried and then probably the cottonwoods alone will not be able to offer a sufficient obstruction to the sand to cause further vertical growth of the ridge. In fact the branches immediately above the top of the ridge may die and the sand, being thus exposed to the action of the wind, may be again blown away. Generally, however, there appears another plant which, to a certain degree, takes the place of the lower limbs of the cottonwoods or, upon the death of the trees, may itself preserve the integrity of the ridge. The vegetational structure at this stage may be termed as follows:

The *Andropogon* Dune Formation.

Facies: *Andropogon furcatus.*

Secondary Species:

Artemisia caudata, *Andropogon scoparius*, *Panicum virgatum.*

The development of this formation on Cedar Point is far inferior to its development at Presque Isle. On Cedar Point the formation is usually more or less mixed with the foregoing formation, as in parts of Ridge 7, and later passes into the following structure:

The *Toxicodendron* Thicket Formation.

Facies: *Toxicodendron pubescens.*

Secondary Species:

Populus deltoides,	*Celastrus scandens,*
Parthenocissus quinquefolia,	*Rhus aromatica,*
Quercus velutina,	*Fraxinus americana,*
Salix amygdaloides,	*Vitis vulpina,*
Ptelea trifoliata,	*Andropogon furcatus,*
Poa compressa,	*Juniperus virginiana.*

This formation is characterized by several lianas or semilianas, which, together with young trees of several species, constitute a more or less definite thicket formation above which stand the older cottonwoods. The last named species is here probably best regarded as a relict of the earlier formations The *Toxicodendron* Thicket Formation is best exemplified on Ridges 6(1) and 6(2), (Moseley).

The *Pinus-Juniperus* Forest Formation

Facies: *Juniperus virginiana,*
Pinus strobus.

Principal Species: *Vagnera stellata.*

Secondary Species:

Quercus velutina,	*Quercus imbricaria,*
Toxicodendron pubescens,	*Tilia americana,*
Populus deltoides,	*Fraxinus americana,*
Fraxinus biltmoreana,	*Salix amygdaloides,*
Platanus occidentalis,	*Ulmus fulva,*
Opuntia humifusa,	*Cyperus schweinitzii,*
Celastrus scandens,	*Rubus procumbens,*
Asclepias tuberosa,	*Arabis laevigata,*
Prunus serotina,	*Rhus aromatica,*
Panicum scribnerianum,	*Smilax herbacea,*
Equisetum robustum.	

The exact status of this formation is not easy to determine with respect to its counterpart on Presque Isle, but it appears that the formation on Cedar Point is a sort of merging of what has been called two distinct formations on Presque Isle The formation is typically exemplified on Ridges 5 and 4 and, in places, on 3.

No alternation is evident between the facies of this formation, but there is, however, a distinct layering; the following layers being evident:

1. Primary Layer —The facies and other trees of larger size.
2. Secondary Layer.—Young trees, mainly of same species as the facies but relatively larger numbers of oaks.
3. Tertiary Layer.—Low shrubs and herbs; *Vagnera*, *Equisetum*, etc.
4. Ground Layer.—Represented very sparingly by occasional fleshy fungi, moulds, myxomycetes, etc.

The formation is characterized by one principal species constituting the *Vagnera stellata* Society. Also conspicuous community and family groups of *Equisetum*.

The *Quercus velutina-imbricaria* Forest Formation.

Facies: *Quercus velutina*,
Quercus imbricaria.

Principal Species: *Aralia nudiflora*,
Washingtonia claytoni.

Secondary Species:

Pinus strobus,	*Juniperus virginiana*,
Tilia americana,	*Prunus serotina*,
Prunus virginiana,	*Fraxinus americana*,
Smilax herbacea,	*Toxicodendron pubescens*,
Rubus nigrobaccus,	*Aralia racemosa*,
Vitis vulpina,	*Parthenocissus quinqefolia*
Vagnera stellata,	*Vagnera racemosa*,
Meibomia dillenii,	*Lespedeza violacea*,
Galium circaezans,	*Helianthus strumosus*,
Ulmus americana,	*Solanum nigra*,
Monarda fistulosa,	*Nabalus albus*,
Phryma leptostachya.	

This formation is best shown towards the north ends of Ridges 3 and 2. The habitat, although originally a xerophytic one with a pure sand soil, has become more and more mesophytic. The water-containing and water-retaining powers of the soil have been much increased by the accumulation of about three inches of humus which acts as a mulch, and also the same general effect is brought about by the continual rise of the water table coincident with the cumulative rise of water in the Lake.

FIG 3 Looking northwest along path from rear of Breakers Hotel, vegetation transitional into the *Pinus-Juniperus* Forest Formation. Note old cottonwoods, young pines junipers, and oaks, and numerous lianas, also conspicuous tertiary layer.

This formation constitutes a forest habitat quite different in several respects from that of the preceding formation. The primary layer being deciduous, and, as a whole, being largely composed of species (oaks) coming into leaf rather late in the season, and, even then, not casting a dense shade, the relative amount of insolation reaching the lower layers in the oak forest is quite large; much larger than in the *Pinus-Juniperus* forest. Due in a large measure, probably, to this relatively greater amount of insolation there are developed in the oak forest much more pronounced layers. The following layers are there evident, aside from the Primary Layer the Shrub and Herbaceous Layers being most important:

1. Primary Layer.—Composed of the facies and other large trees.

2. Secondary Layer.—Younger individuals of the species constituting the primary layer, together with a very few large shrubs and small trees. Not a well defined structure in the formation as represented on Cedar Point.

3. Tertiary or Shrub Layer.—Composed of bushes and shrubs together with a tangle of lianas and certain tall herbaceous plants:

Rubus nigrobaccus,	*Smilax herbacea,*
Aralia racemosa,	*Vitis vulpina,*
Parthenocissus quinquefolia,	*Prunus virginiana,*
Nabalus albus,	*Rhus aromatica,*
Toxicodendron pubescens,	*Helianthus strumosus,*
Agastache nepetoides,	*Steironema ciliatum,*

4. Herbaceous Layer. Exhibiting more or less alternation with the Tertiary Layer and often grading imperceptibly into it, being at the same time of about equal importance with reference to the formational structure. This structure is very largely composed of herbaceous perennials with well developed underground stems, "Geophytes,"—Raunkiaer.[10]

Washingtonia claytoni,	*Aralia nudiflora,*
Vagnera stellata,	*Meibomia dillenii,*
Lespedeza violacea,	*Galium circaezans,*
Galium triflorum,	*Phyrma leptostachya,*
Polygonum virginianum,	*Vagnera racemosa,*
Salomonia commutata,	*Monarda fistulosa.*

5. The Ground Layer. This indefinite and variable layer is characterized by a few fungi and mosses living on the humus and dead leaves.

10. Raunkiaer, C. Types Biologiques pour la geographie botanique. Oversigt over det Kgl. Danske Videnskabernes Selskabs Forhandlinger, 1905 : 347–437.
Liberal translation into German by Dr. F. Fedde. In Aus de Natur. Oct. 1 & 15; Nov. 1 & 15; Dec. 1 & 15; 1907, and Jan. 1 & 15, 1908.

The *Ulmus-Acer* Forest Formation.

Facies: *Ulmus americana*,
Acer rubrum.

Secondary Species:

Fraxinus americana,	*Fraxinus lanceolata*,
Quercus velutina,	*Acer nigrum*,
Platanus occidentalis,	*Ostrya virginiana*,
Sambucus canadensis,	*Rubus occidentalis*,
Rubus nigrobaccus,	*Ribes cynosbati*,
Parietaria pennsylvanica,	*Parthenocissus quinquefolia*,
Lactuca floridana,	*Impatiens biflora*,
Helianthus decapetalus,	*Phytolacca decandra*,
Solanum nigrum,	*Galium triflorum*,
Boehmeria cylindrica,	*Botrychium virginianum*,
Campanula americana,	*Circaea lutetiana*,
Dryopteris spinulosa,	*Eupatorium ageratoides*.

The accumulation of humus in the soil of the ridge as well as the general rise of water in the Lake has brought about a gradual change towards mesophytic, or even hydrophytic, conditions so that this formation, as represented on Ridge No. 1, is practically the same as would be the formation derived upon the filling up of a hydrophytic pond or swamp by the accumulation of humus. In either case there is a rich humous soil with great capillarity and a high water table.

The formation as represented on Cedar Point is not of large area and it has, moreover, been much disturbed by man's activities, and no effort was made on the part of the writer to determine the minor formational structure.

THE LAGOON-MARSH-WET MEADOW-THICKET-FOREST SUCCESSION.

In the writer's studies on the ecology of Presque Isle there was found to be represented there a remarkable series of lagoons, these being evident in all stages from extreme youth to mature old age, so that the successive development of the lagoon vegetation was not difficult to decipher. On Cedar Point, however, the lagoons are few and the successional series is rather incomplete. Nevertheless, such stages as are in evidence show much similarity to corresponding stages on Presque Isle so that, by correlation, a fair idea may be gained of the probable structure of the lagoon vegetation for the missing stages.

For a lagoon or pond the normal tendency is to become filled with accumulating vegetable debris, the surrounding vegetation being arranged in concentric zones, each inner one more hydrophytic, and, with the accumulation of vegetable debris and the elevation of the respective habitats, there is a continual advance of all the zones towards the deeper central portion of the lagoon

or pond. On Cedar Point, however, the elevation of the habitat of the various zones due to the accumulation of vegetable matter must to some degree be counteracted by the general rise of the water table consequent to the cumulative rise of water in Lake Erie,—2.14 feet per century. It seems likely that, in some cases at least, the general movement may be reversed as to the concentric vegetational formations, so that they may move away from the central portion of the depression; thus, from habitats more hydrophytic to less hydrophytic ones.

At the northeast corner of Cedar Point sand is rapidly accumulating along the shore to the south of the Jetty Protection or Breakwater and a lagoon is now (1907) being segregated from the Lake near the old light-house building. There is at this place a considerable indrifting of organic drift debris of various sorts so that the vegetation shows somewhat more of an affinity to that of a humus marsh or pond than is usual in beach lagoons. The initial stage here appears from the studies given it (1905–7) to be essentially as follows:

Stage A.

a. *Potamogeton* Formation.
b. *Populus-Salix* Formation.

The *Potamogeton* Formation.

Facies: *Potamogeton pectinatus.*
Secondary Species:
Vallisneria spiralis, *Potamogeton natans, etc.*

The *Populus-Salix* Formation.

Facies: *Populus deltoides,*
Salix cordata.
Secondary Species:
Salix fragilis (?), *Salix lucida,*
Cakile edentula, *Strophostyles helvola,*
Xanthium commune.

This latter formation may be considered as identical with the beginning of a *Populus-Salix* Ridge Formation but, under the conditions leading to the development of a sand ridge, the willows soon disappear while, under the more uniform conditions leading through the different stages of a lagoon succession, the willows are relatively quite important.

In the lagoon succession at Presque Isle the second stage shows the following structure, this appearing to be typical also for the Cedar Point succession, although somewhat mixed in the lagoon under discussion:

Stage B.

a. The *Potamogeton* Formation.
b. The *Juncus-Eleocharis* Formation.
c. The *Populus-Salix* Formation.

In the older part of this lagoon the *Potamogeton* Formation shows little change from its structure in the youngest part of the lagoon, excepting that the constituent plants are larger and more numerous. At the edge of the water and extending a few inches up onto the wet sand is a zone which may be termed:

The *Juncus-Eleocharis* Formation.

Facies: *Juncus balticus.*
Eleocharis intermedia.

Secondary Species:

Cyperus rivularis,	*Roripa palustris.*
Populus deltoides,	*Salix cordata,*
Salix lucida.	

There is but little change in the outer *Populus-Salix* zone in this stage, aside from the further growth of the individuals and the appearance of occasional ruderal species. In the oldest and most highly developed parts of the lagoon under consideration the vegetation is in the beginning of what may be termed Stage C, with the following structure:

Stage C.

a. The *Potamogeton* Formation.
b. The *Typha-Scirpus* Formation.
c. The *Salix* (*spp.*) Formation.
d. The *Populus-Salix* Formation.

In this stage there is again little change in the *Potamogeton* Formation, but in the shallow water near the shore, and also taking the place of the *Juncus-Eleocharis* Formation on the wet bank at the water's edge, there has appeared a new vegetational structure as follows:

The *Typha-Scirpus* Marsh Formation.

Facies: *Scirpus validus,*
Scirpus americanus,
Typha latifolia.

Secondary Species:

Sparganium eurycarpum,	*Juncus balticus,*
Eleocharis intermedia,	*Scirpus atrovirens,*
Sagittaria latifolia,	*Alisma plantago-aquatica,*
Roripa palustris,	*Potamogeton natans,*
Castalia tuberosa.	

Among the secondary species are a few, —*Alisma, Roripa, Sagittaria,*—which are more typically representative of the humus swamp or marsh margin than of a beach lagoon and their presence here is to be regarded as due to the rather large amount of organic matter (drift debris) incorporated into the soil of the habitat. The vegetation of this formation catches considerable sand and contributes quite appreciably to the filling of the lagoon.

The facies exhibit a distinct alternation in the *Typha-Scirpus* Formation. On the wet bank, and extending out into the water to a variable depth of about a foot, is the *Scirpus americanus* Consocies, alternating here and there with the *Typha latifolia* Consocies, while beginning in 6 or 8 inches of water and extending out into the deeper water of the lagoon, is the *Scirpus validus* Consocies, the latter thus forming a zone in the deeper part of the habitat. In this consocies *Castalia* is beginning to appear in a few places in the deepest part and, providing the marsh formation does not build up the soil and advance too rapidly, there may soon be initiated a new formation between the *Typha-Scirpus* Formation and the *Potamogeton* Formation.

In the upper part of the *Typha-Scirpus* Formation, and extending up to the outer *Populus-Salix* Formation, there is a zone the status of which was not satisfactorily determined. This zone has been provisionally designated as follows:

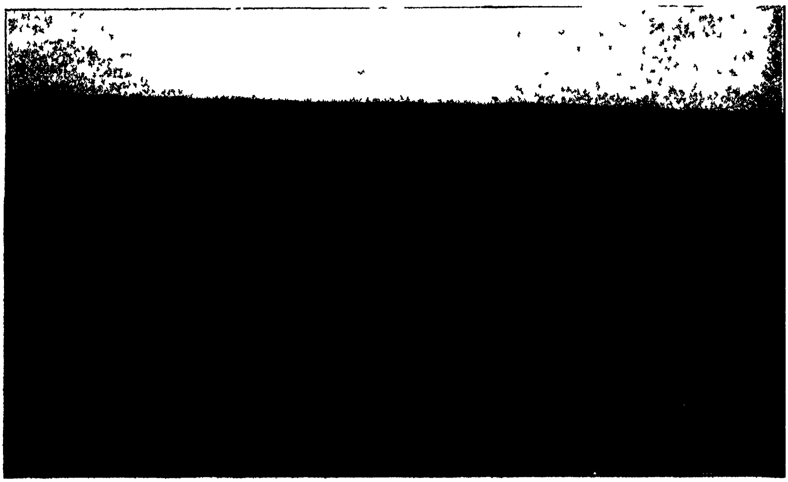

FIG. 4. Looking east across the new lagoon a few rods south of the Break-water. *Typha-Scirpus* Formation conspicuous. Lake in distance and bar visible just beyond the marsh vegetation. Young cottonwoods and willows in immediate foreground are submerged by unusually high water.

The *Salix* (*spp.*) Formation.

This structure probably represents a transitional condition the true status of which will become evident in the future. At present it consists of several species of *Salix* with scattering individuals of *Vitis vulpina*, *Bidens frondosa*, *Polygonum pennsylvanicum*, *Ambrosia trifida*, etc. The structure is evidently the beginning of a thicket formation similar in position to the *Myrica-Salix* thicket formation on Presque Isle.

Proceeding to the next oldest lagoon on Cedar Point we have the Lily Pond just to the west of the highest portion of Ridge No. 6. The present status of the vegetation around the pond is about that termed, for the succession on Presque Isle, stages "H" and "I". About the Lily Pond on Cedar Point the following general vegetational structure appears:

a. The *Potamogeton* Formation.
b. The *Castalia-Nymphaea* Formation.
c. The *Decodon-Persicaria* Formation.
d. The *Cephalanthus-Cornus* Thicket Formation.
e. The *Rhus hirta* Thicket Formation.
f. The *Ulmus-Acer* Forest Formation.

There should be in the deepest part of the pond a *Chara* Formation, but, for lack of the proper facilities for studying this vegetation this point was not determined. In similar ponds on Presque Isle there was evidence of a central *Chara* formation, although Pieters found in Lake St. Clair that this formation was usually scanty or entirely absent on a sandy bottom but present on a clay or alluvial bottom.[11]

The *Potamogeton* Formation.

This formation has here the following structure:

Facies: *Potamogeton pectinatus*,
Potamogeton natans.

Principal Species: *Utricularia vulgaris*.

Secondary Species:

Naias flexilis,	*Vallisneria spiralis*,
Philotria canadensis,	*Potamogeton sp.*

The *Castalia-Nymphaea* Formation.

This formation is perhaps relatively of more importance in the vegetational structure here than is the preceding formation: Its structure is essentially as follows:

Facies: *Castalia tuberosa*,
Nymphaea advena.

Secondary Species:

Potamogeton natans,	*Philotria canadensis*,
Utricularia vulgaris,	*Potamogeton sp.*,
Scirpus validus,	*Decodon verticillatus*.

This formation, relatively among its competitors, is a rapid soil-former. The plants of the formation typically exhibit large rootstocks, which upon their decay contribute considerably to the accumulation of humus, while the tangled mass of petioles and leaves in and on the water not only catch much floating debris, but, upon their decay, also add to the humus beneath.

11. Pieters, A. J. The Plants of Lake St. Clair. Michigan Fish Commission Bull. 2 : 6 and 9. 1894.

FIG. 5. Looking west across the northern part of the Lily Pond. Beginning at the left is the *Castalia-Nymphaea* Formation somewhat mixed with the *Potamogeton* Formation and consecutively to the right may be seen the *Decodon-Persicaria*, *Cephalanthus-Cornus*, *Rhus hirta*, and *Ulmus-Acer* Formations.

In the course of time the soil may have accumulated to such an extent that the shallower water may offer conditions suitable for other species than those of the resident formation and, by invasion and ecesis, another formation may eventually occupy the habitat. In the Lily Pond the formation next outside of the lily zone is the following:

The *Decodon-Persicaria* Formation.

Facies: *Decodon verticillatus*,
Persicaria laurina.

Secondary Species:

Naumbergia thyrsiflora,	*Alisma plantago-aquatica*,
Solanum dulcamara,	*Cephalanthus occidentalis*,
Pontederia cordata,	*Sagittaria latifolia*,
Nymphaea advena.	

Further study of this formation might, perhaps, result in the placing of *Persicaria laurina* as a principal species, but it probably is best regarded as one of the facies. The *Decodon-Persicaria* Formation forms soil quite rapidly and upon the emergence of the soil above the ordinary water level the following structure takes possession:

The *Cephalanthus-Cornus* Thicket Formation.

Facies. *Cephalanthus occidentalis*,
Rosa carolina,
Cornus stolonifera.

Secondary Species:

Salix lucida,	*Persicaria laurina*,
Salix cordata,	*Alisma plantago-aquatica*,
Lathyrus palustris,	*Scirpus americana*,
Typha latifolia,	*Eleocharis intermedia*,
Calamagrostis canadensis,	*Lathyrus palustris*.

Towards the southern end of the pond there is a patch of wet meadow constituting a remnant, probably, of a once somewhat larger *Calamagrostis* Wet Meadow Formation. The latter formation is represented on Presque Isle by the strong *Cladium-Calamagrostis* Wet Meadow Formation, which, on lagoon banks with gentle slopes and correspondingly wide habitat zones, constitutes an important formation following the rushes and preceding the thicket stage . *Cladium* does not appear on Cedar Point but the *Calamagrostis canadensis* Wet Meadow Formation, really a consocies only of the northward-ranging *Cladium-Calamagrostis* formation, is well developed in the Cedar Point marsh succession and will be discussed further under that head.

In the *Cephalanthus-Cornus* Thicket Formation there is usually more or less of a mixture of the facies but sometimes a more definite structure is evident. Where there is a segregation

of the facies into definite structures the *Cephalanthus occidentalis* Consocies occupies the part of the habitat adjoining and grading into the *Decodon-Persicaria* habitat, while the other two facies alternate with each other in the outer more mesophytic part of the habitat. The formation is here bordered by a shrub formation which is approaching old age and which may more properly be regarded as a bordering thicket associated normally with the *Calamagrostis* Wet Meadow Formation.

The Rhus hirta Thicket Formation.

Facies: *Rhus hirta.*

Secondary Species:

Cornus amomum,	*Cornus stolonifera,*
Salix cordata,	*Salix nigra,*
Salix amygdaloides,	*Salix lucida,*
Vitis vulpina,	*Parthenocissus quinquefolia,*
Dryopteris thelypteris,	*Rubus nigrobaccus.*

This formation apparently displaces the *Salix* (*spp.*) Formation where dryer and more mesophytic conditions are approached. This also represents a consocies of a more northern formation which on Presque Isle was of considerable importance and was there designated as the *Rhus-Alnus* Thicket Formation.

The *Ulmus-Acer* Forest Formation.

There are evidences that this formation will come in instead of the *Quercus velutina-imbricaria* Forest Formation in the zone first occupied by the *Populus-Salix* Formation. The elevation of the water table and the consequent hydrophytic tendency of this habitat probably has something to do with the exclusion of the oak forest from this zone. Where the cotton-woods have built up a steep ridge in close proximity to the water, as on the east side of the Lily Pond, the vegetation will, of course, be more xerophytic and will follow the stages as indicated for the ridge succession, finally passing into the oak forest and this will not pass into the *Ulmus-Acer* forest until considerably more mesophytic or even semi-hydrophytic conditions prevail by the accumulation of much humus or by the rise of the water table, or both.

To the southwest of this pond there is a small narrow pond almost choked up with vegetation, the whole being somewhat further developed in its successional stages. The *Cephalanthus-Cornus* Thicket Formation is strongly developed and, in the course of a few years, unless the rise of the water is too rapid, the shrubs will have occupied the whole central portion of the depression.

Previous to the construction of the artificial canals or "Lagoons" in connection with the amusement features of the pleasure

resort there were other lagoons between the ridges in advanced stages of the lagoon succession, mostly in the thicket and forest stages although the rise of the water seems to have brought about marsh conditions in places. These older lagoons were not much studied as to the structure of their vegetation before they were destroyed by the dredging out of the artificial canals.

To the left of the path leading to the Eastland Dock and not far from the outlet of the artificial "Lagoons" is a small depression which is interesting in that it represents a secondary pond or lagoon succession. The rise of water in the Lake has finally brought about the rise of the water table into the bottom of a depression which was formerly dry land and there will accordingly follow in due time, the displacement of the present *Ulmus-Acer* forest by a secondary hydrophytic succession.

FIG. 6. Depression between outlet of "Lagoons" and the path to the Eastland Dock.

The present vegetation in and immediately around the water is as follows:

Primary Layer:

Acer saccharinum, (*perhaps some A. rubrum*)........60%,
Ulmus americana..................................15%,
Platanus occidentalis............................15%,
Fraxinus americana...............................10%,
Fraxinus nigra, one small tree.

Subordinate Layers: Below the primary layer there appear to be only species from the lower layers of the surrounding forest formation, with the one exception that in the pond is con-

siderable *Lemna trisulca*. Around the borders of the pond is a vigorous growth of the following species from the adjoining forest formation:

Impatiens biflora,
Dryopteris spinulosa,
Dryopteris thelypteris,
Geranium robertianum,
Adicea pumila,
Washingtonia claytoni.

Back of the cottages near the Government Dock there is a swampy area which evidently represents advanced stages of the lagoon succession in a lagoon which must have been initiated during severe northwest storms in the Bay. The depression is long and narrow and runs almost at right angles to the general direction of the large sand ridges of the Ridge Section, and is very nearly parallel to the general direction of the shoreline of the Bay near by. The vegetational structure of this depression is approximately a *Calamagrostis* Wet Meadow Formation in the central portion and rapidly invading this area from the sides is the *Cephalanthus-Cornus* Thicket Formation, around which, and in many places in which, is a strongly developed *Rhus hirta* Thicket Formation

THE-BEACH-SAND PLAIN-THICKET-FOREST SUCCESSION.

In the time intervals between the initiation of the great sand ridges on Cedar Point there was, evidently, a gradual accumulation of sand along the beach of the Ridge Section of the peninsula, causing an outward growth of the land form without the building up of ridges, or, if ridges were initiated by the cutting off of lagoons, the sand drifted in from the adjoining land and from the new beach to such an extent that the lagoons were soon filled, the final result being, in either case, a level expanse of sand plain elevated but a few feet above the level of Lake Erie.

A considerable portion of Cedar Point consists of what may be called Sand Plain. This habitat comprises: (a), the level expanses between the ridges of the Ridge Section, (b), the main part of the Bar Section; and (c), a large proportion of the Dune Section, including also the more or less transitional portion of the peninsula between the Dune Section and the Ridge Section where part of the amusement tents and trinket stands of the Pleasure Resort are located. It is very difficult at times to draw more than an arbitrary line between sand plain and dune, especially in the Dune Section; both these physiographic structures owe their elevation above Lake level to the accumulation of wind drifted sand and differences of topography rather than of origin must be taken into consideration when an attempt is made at classification.

The Lower Beach—The *Chlamydomonas* Formation.

Following in part Cowles' classification[12] of the beach habitats, there may be distinguished, first, the Lower Beach,[13] comprising that part of the beach washed by the waves of ordinary summer storms and thus, chiefly by reason of the mechanical violence of the waves and the instability of the sub-stratum, practically devoid of plant life. However, as Cowles noted along the lower beach of Lake Michigan and as the writer found also on the Lower Beach of Presque Isle, a species of *Chlamydomonas*, a one-celled motile alga, occasionally occurs so abundantly in the sand as to cause a distinctly green coloration These plants are perhaps more correctly to be regarded as migrants from the waters of the Lake, but, being so abundant in certain wet periods and being also the only plant found commonly in the habitat, we have termed the formation the *Chlamydomonas* Formation.

The Drift Beach—The *Cakile-Xanthium* Formation.

Extending from the upper limit of the waves of ordinary summer storms, i. e., the upper edge of the Lower Beach, up to the upper limit of the waves of severe winter storms, there is a zone which may be termed the *Drift Beach*,[14] which is characterized ordinarily by freedom from the violence of the waves of summer storms but is subjected to severe mechanical action of the waves of winter storms, at which time there is usually left a line of driftwood which marks, through the following season, the upper extent of the wave action.

The habitat as thus characterized is inhabited by a vegetation composed of such annuals as can endure the summer environment, the seeds having been left in their present position by wave action. Perennials and biennials are, of course, barred from this habitat by the destructive effects of wave action during the winter. The habitat presents above the surface of the sand conditions of excessive insolation, great and often very sudden extremes of temperature, great fluctuation in the water content of the air, and, also, high winds, and is thus distinctly xerophytic. The edaphic conditions are, however, distinctly hydrophytic below the surface layer of sand so that the habitat may, as a whole, be designated as dissophytic.[15] The vegetation

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12. Cowles, H. C. The Ecological Relations of the Vegetation of the Sand Dunes of Lake Michigan. Bot. Gaz. 27 : 95–117, 167–202, 281-303, and 361–391. Feb., Mar., Apr., and May, 1899.

13. Cowles, H. C. l. c. Bot. Gaz. 27 : 114–117.

14. MacMillan's "Mid-strand" (Lake of the Woods); Schimper's "Mid-shore"; Cowles' "Middle Beach" (Lake Michigan); Ganong's "New Beach" (Miscou Island); are all synonyms for the habitat here designated as the Drift Beach.

15. See Clements—Research Methods in Ecology.

here consists, then, of dissophytic annuals, constituting as determined by the facies the *Cakile-Xanthium* Formation:

Facies: *Cakile edentula,*
Xanthium commune,[16]
Polanisia graveolens.

Principal Species: *Strophostyles helvola.*

Secondary Species:
Cenchrus tribuloides, *Euphorbia polygonifolia.*

There is considerable alternation in this formation, the *Cakile edentula* Consocies occupying the more exposed Lake beach, while the *Xanthium commune* Consocies is best seen in places along the less exposed Bay beach. *Polanisia* is more indifferent as to its location, it occurring sometimes alone but more usually indiscriminately mixed with the other facies.

The Sand Plain—The *Artemisia-Panicum* Formation.

Where the continuity of the outward growth of the land form of the peninsula has not been broken by the formation of a sand ridge it is often difficult to draw the line between the upper limit of the Drift Beach and the lower limit of the Sand Plain.[17] Upon the burial of the driftwood which accumulates in the upper part of the Drift Beach by the indrifting of sand, the land becomes sufficiently elevated to form a slightly different habitat which is, of course, free from the mechanical violence of the waves at any time, other than at very rare periods. The habitat thus may support a vegetation of annuals, biennials, and perennials, depending simply upon their ability to cope with the otherwise severe conditions of environment.

The vegetation of the Sand Plain may, from its facies, be designated as the *Artemisia-Panicum* Formation. It has essentially the following structure:

Facies: *Artemisia caudata,*
Panicum virgatum.

Principal Species:
Salix interior & var. wheeleri.
Arenaria serpyllifolia,
Arabis lyrata.

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16. This species is probably best denominated as *Xanthium commune*, rather than as *X. canadense*, as given in the Flora of Cedar Point.—W. A. Kellerman and O. E. Jennings. Ohio Nat. 4 : 186–190. June, 1904.

17. Synonymous habitats with this are Macmillan's "Back Strand" (Lake of the Woods); Cowles' "Upper Beach" (Lake Michigan); and Ganong's "Grass Plain" (Miscou Island).

Secondary Species:

Opuntia humifusa,	*Oenothera oakesiana,*
Oenothera biennis,	*Andropogon furcatus,*
Asclepias syriaca,	*Panicum scribnerianum,*
Cyperus schweinitzii,	*Arabis canadensis,*
Euphorbia polygonifolia,	*Apocynum cannabinum,*
Acerates viridiflora,	*Ceratodon purpureus,*
Asclepias tuberosa,	*Cladonia sp.*

Species belonging more properly to other adjoining formations are as follows:

Quercus velutina,	*Quercus imbricaria,*
Ptelea trifoliata,	*Rhus aromatica,*
Toxicodendron pubescens,	*Arctostaphylos uva-ursi,*
Polanisia graveolens,	*Strophostyles helvola.*

The willow appears in places to dominate the formation during a good part of the growing period and under such conditions may de designated the *Salix interior* Society. Over limited areas of the older and more protected parts of the Sand Plain the *Arenaria serpyllifolia* Society and the *Arabis lyrata* Society characterize quite conspicuous vernal aspects.

The minor structure of this formation requires much further study. Especially after a careful instrumental determination of the environmental characteristics of the various parts of the habitat, a considerable modification might be found necessary. Among the more prominent characters displayed among component species of the formation may be mentioned the relatively large proportion of biennials and perennials. The formation during the hot portion of the summer is subjected to extremely severe and xerophytic conditions, at least during short periods, and it is probably to this that the structure af the vegetational formation is due. The formation is essentially an open structure and often displays prominent ecological families and communities as, for instance, with *Opuntia humifusa, Asclepias tuberosa,* etc.

Certain instrumental observations were made in parts of the sand plain during the summer of 1905 as to temperature, relative humidity, etc., and, as showing the extremely xerophytic conditions to which the plants of the sand plain are exposed at times, the following records may be of interest. On a day in middle August, 1905, in one of the open spaces between the advance guard of the oak forest north of the Laboratory where the slight breeze was so faint as to be inappreciable, the temperature of the air at a height of 1½ feet was 83 degrees Fahrenheit, while the sand at the surface just beside one of the communities of *Opuntia humifusa* was 142 degrees, taken at 1:30 P. M., while the maximum temperature for the day reported by the U. S. Weather Bureau

Station at Sandusky, about three miles distant across the Bay was 79 degrees, Fahr. (At 1 inch above the surface of the soi the air was 118 degrees; at 6 inches, 89; at 12 inches 84,—thermometer properly shaded.)

Thus far the vegetational structure in the succession under consideration has been comparatively uniform over the entire Sand Plain wherever the latter may be situated on the peninsula but the *Artemisia-Panicum* Formation may be invaded and eventually succeeded by a formation having distinctly northern phytogeographical relationships, or, on the other hand, the succeeding formation may be one of more southern affinities

FIG. 7. Small area of Sand Plain enclosed by *Quercus velutina* and *Q imbricaria*, *Celtis occidentalis* Note communities of *Opuntia humifusa* with scattering *Artemisia*, *Panicum virgatum*, *P scribnerianum* and *Verbascum thapsus*

In the work on Presque Isle the writer found a considerable difference in both the habitat and in the corresponding vegetation in different portions of the Sand Plain such that two formational series could be distinguished as early in the succession as the Drift Beach. On Cedar Point, however, there are no such evident distinctions early in the succession but the critical period appears to be in the sand plain stage.

Accordingly, the succeeding vegetational structures with a more southern phytogeographical relationship will first be taken up, after which the structures of northern affinities will be dis-

cussed. The final decision as to the influences determining whether the one or the other phytogeographical element shall predominate must be deferred until exact instrumental determinations may have been made of the various environmental factors in the different parts of the Sand Plain, but, if an opinion may be here ventured, it seems probable that the ecological conditions are so nearly equally suitable for the two elements that historical considerations become of prime importance, and that a very slight fluctuation of the ensemble of ecological factors from one direction to the other may be sufficient to determine which vegetation shall gain the ascendency.

The vegetation of the Bar Section as so well described by Moseley consists almost entirely of the *Artemisia-Panicum* Sand Plain Formation, there being on the Bay side a narrow strip of more hydrophytic vegetation just at the edge of the marsh. The whole bar is shifting over onto the marsh and it appears likely that the conditions do not reach such a stace of stability as to permit the development of a well market thicket stage. Instead of an outward growth of che land form towards the Lake there is here exactly the opposite taking place and the real succession of habitats is abnormal, being from marsh through sand plain to beach.

At the south end of the small peninsula between Biemiller's Cove and the Bay there is a small area of the *Artemisia-Panicum* Formation, but there is no very well marked area of sand plain of any considerable size in the Dune Section, small areas being scattered here and there between the dunes and blow-outs and in the oak forest Between the Dune Section and the Ridge Section are limited areas of a thicket stage which may be called the

Rhus-Prunus-Toxicodendron Thicket Formation.

The apparent facies being:
Rhus aromatica,
Prunus virginiana,
Toxicodendron pubescens.

This thicket formation is soon followed by the

Quercus velutina-imbricaria Forest Formation,

this having here essentially the same structure as described for the Ridge Succession. The thicket formation succeeding the *Artemisia-Panicum* Formation on Cedar Point is not nearly so prominent or vigorous a structure as is the corresponding *Myrica* Thicket Formation of Presque Isle.

Taking up now the succession of northern phytogeographic affinities we have, as follows:

THE BEACH-SAND PLAIN-HEATH-FOREST SUCCESSION.

This is the more common succession on the Cedar Point sand plain where the habitat is of several years duration. It is doubtful, if this succession were introduced onto the Bar Section, that it could reach maturity. In the Dune Section the heath and forest stages are essentially identical with the dunes and blowouts and, as the former often merge imperceptibly into the latter two formations the discussion of these stages will be taken up in connection with the discussion of the dune and blowout vegetation.

THE DUNE AND BLOWOUT SUCCESSIONS.

Under the above heading may be included a number of secondary formations which, taken together, make up most of the vegetation of the Dune Section of Cedar Point. As Moseley has pointed out,[18] this part of the peninsula represents a portion of the original mainland upon which has been heaped the loose sand, coincident with the rise of the waters of the Lake. There can be no doubt that the land was originally covered here with forest, probably an *Ulmus-Acer* forest formation, which later perhaps gave way to marsh vegetation but upon which, still later, has been heaped the loose sand bringing about conditions suitable for the present dune and blowout formations.

The *Ammophila* Fringing-Dune Formation.

Along most of the Lake shore of the Dune Section the Drift Beach extends up to a well-marked *Ammophila* fringing dune. This species of grass has the ability to grow upwards for a number of feet if continuously buried more deeply by accumulating sand and as the sand accumulates around the ever higher obstruction a gently sloping ridge is finally built up. The height of such a dune or ridge is determined by the height to which the grass can grow vertically, the amount of obstruction which it offers the drifting sand, and, finally, the force of the wind which tends to tear the dune down again.

The structure of the *Ammophila* Fringing-Dune Formation is quite simple:

Facies: *Ammophila arenaria.*
Principal Species: *Psilocybe ammophila.*
Secondary Species:

Euphorbia polygonifolia,	*Andropogon scoparius,*
Artemisia caudata,	*Strophostyles helvola,*
Cakile edentula,	*Panicum virgatum,*
Salix interior.	

18. Moseley, E. L. l. c. pp. 220–223.

During certain damp periods the agaric appears quite abundantly and can quite appropriately be designated as a principal species characterizing the *Psilocybe ammophila* Society and determining a summer aspect of the formation. The secondary species as may be noticed, are all invaders from the drift beach in front or from the habitat behind the fringing-dune. The secondary species are never very abundant in the dune.

The successor to the fringing-dune is somewhat indefinite. The *Ammophila* apparently dies out as soon as deprived of freshly drifting sand and, in case the beach grows outwards, the grass dies out and the sand is blown away by the wind, or, in some cases other dune plants may successfully invade the dune and hold the sand in place. Among these latter may be mentioned *Elymus* and *Andropogon* and, to some extent, *Arctostaphylos.*

The *Elymus* Dune Formation.

Facies: *Flymus canadensis,*
Elymus striatus.

Secondary Species:

Euphorbia polygonifolia,	*Artemisia caudata,*
Andropogon scoparius,	*Panicum virgatum,*
Tilia americana,	*Arctostaphylos uva-ursi.*

This formation is quite well represented along the Lake shore to the south of the bathing pavilion of the pleasure resort and it there apparently occupies an old *Ammophila* fringing-dune which has been left somewhat inland by the outward growth of the land form at this place, so that the *Ammophila* has been deprived of freshly drifting beach sand and has died out.

The stage succeeding the *Elymus* Dune Formation is here a mixed formation in which *Tilia americana*[19] and *Juniperus virginiana* are prominent, this formation eventually giving way to the *Quercus velutina-imbricaria* Forest Formation.

The *Andropogon* Dune Formation.

Facies: *Andropogon scoparius,*
(*Andropogon furcatus* also to a limited extent.)

Secondary Species: The secondary species are here about the same as those in the *Elymus* Dune Formation and it is not improbable that these two so-called formations may represent simply consocies of one and the same formation. *Andropogon scoparius,* as is also the case with *Panicum virgatum,* often forms about the separate clumps little dunes sometimes reaching a height of a couple of feet, but these miniature dunes disappear with the death of the grass and do not pass by succession into other vegetational structures.

19. Cowles, H. C. l. c. Bot. Gaz. 27 : 361–367. The *Tilia* dunes are along parts of the Lake Michigan dune district an important feature.

The successor to the *Andropogon* Dune Formation may be one of several different structures. In the formation are often to be found invaders, of the following species: *Prunus virginiana, Juniperus virginiana, Parthenocissus quinquefolia, Arctostaphylos uva-ursi, Ptelea trifoliata, Toxicodendron pubescens, Tecoma radicans*, so that the succeeding stage may be expected to be either a heath or a thicket. The larger part of the vegetation in the middle of the Dune Section corresponds closely to the vegetation of Cowles' "Dune Complex" of the Lake Michigan dune

FIG. 8. A miniature dune formed about a clump of *Panicum virgatum*, in a large blowout to the north of the Lake Laboratory.

region, and the instability of the sand is here such that a genetic series of the formations is a very difficult problem. However, it appears to the writer that the following formation would normally succeed the grass dune formations in the vicinity of the Lake Laboratory:

The *Prunus-Rhus* Dune-Thicket Formation.

Facies: *Prunus virginiana*,
Rhus aromatica,
Ptelea trifoliata.

Principal Species: *Tecoma radicans*.

Secondary Species:

Gleditsia triacanthos,	*Toxicodendron pubescens,*
Parthenocissus quinquefolia,	*Celastrus scandens,*
Juniperus virginiana,	*Prunus serotina,*
Quercus velutina,	*Amelanchier sp.,*
Panicum virgatum,	*Vitis vulpina,*
Andropogon scoparius,	*Artemisia caudata,*
Elymus striatus,	*Rubus nigrobaccus,*
Asclepias syriaca,	

The various dunes scattered about in this section of the peninsula exhibit considerable alternation as to the facies so that there may be distinguished the *Prunus virginiana* Consocies, the *Rhus aromatica* Consocies, and the *Ptelea trifoliata* Consocies. These three structures are, however, often mixed indiscriminately on the same dune.

FIG 9 The Dune Section, looking southwards from the Lake Laboratory. To the left are the dunes and blowouts, between which and the Bay to the right is the forest strip, here mainly consisting of the *Ulmus-Acer* and *Ailanthus* formations. (Photograph by Prof. Herbert Osborn)

One of the most noteworthy peculiarities of this vegetation is the relatively large percentage of lianas and it is, in many cases, due more to the presence of these plants than to the other vegetation that the integrity of the dune is preserved against the vigorous action of the wind. In fact it appears that many of the dunes were initiated by the lianas or at least held by them until the invasion of the shrubs was accomplished. Especially noticeable in this connection are *Vitis vulpina* and *Parthenocissus quinquefolia.*

If the shore line of the Dune Section were advancing towards the Lake there would in all probability be a corresponding advance of the *Quercus velutina-imbricaria* Forest Formation over the dunes towards the east but, as conditions are at present, there seems to be only in a few places any real advance made by the oak forest and, practically, a state of equilibrium may be said to exist as to this phase of the question

FIG 10 A dune controlled by the *Prunus virginiana* Consocies of the *Prunus-Rhus* Dune Thicket Formation. Note secondary species· *Juniperus virginiana, Asclepias syriaca, Panicum virgatum* In blowout surrounding dune note *Panicum virgatum, Salix interior* This dune appears in distance in left third of preceding illustration

Towards the northern portion of the Dune Section the grass dune formations are followed by a formation consisting of evergreen shrubs with northern phytogeographical relationships, this formation being termed:

The *Arctostaphylos-Juniperus* Heath Formation.

This formation, once established on a dune, brings about more stable conditions than does the *Prunus-Rhus* Thicket Formation. The vegetation being evergreen the winter winds are obstructed much more than is the case with a deciduous dune vegetation and not only are more stable conditions brought about but more sand is deposited by the wind. The structure of this formation is as follows:

Facies: *Arctostaphylos uva-ursi*,
Juniperus virginiana.
Secondary Species:

Andropogon scoparius,	*Panicum virgatum*,
Lithospermum gmelini,	*Quercus imbricaria*,
Quercus velutina,	*Celastrus scandens*,
Toxicodendron pubescens,	*Parthenocissus quinquefolia*,
Rubus procumbens.	

The heath on Presque Isle with somewhat more northern conditions of environment is regularly followed by a white pine forest which, in turn, is regularly replaced by a black oak forest. On Cedar Point, however, the pine stage does not appear to inter-

FIG. 11. One of the park-like vistas in the *Quercus velutina-imbricaria* Forest Formation in the northern part of the Dune Section. *Juniperus* and *Celtis* with the oaks, the border thicket being of *Toxicodendron*, *Rhus aromatica*, *Prunus virginiana*, while in sand plain are *Panicum virgatum*, *P. scribnerianum* and *Lepidium virginicum*.

vene but the heath stage is directly followed by the *Quercus velutina-imbricaria* Forest Formation, typically as described under the Cottonwood Bar-Ridge-Thicket-Forest Succession. In the northern part of the Dune Section there appears to be some advance towards the Lake on the part of the oak forest, young oaks being quite common in the heath at some distance in advance of the mature trees.

The *Quercus velutina-imbricaria* Forest Formation, however, in this part of the peninsula is far from being a continuous closed forest but is interspersed here and there with areas of open sand plain, giving to the whole a park-like aspect.

The Blowout Formations.

With the formation of dunes by the piling up of sand around the vegetation, there is a tendency towards the deflection of the wind so that its abrasive effect is intensified in open areas in close proximity to the dune. The usual result of this is a hollowing out of the sand at such points, constituting thus a "blowout." Cowles in his work on the sand dunes of Lake Michigan has termed as "fossil beaches" such beach habitats as have been covered over with dune sand or sand plain and later exposed again by the drifting away of the sand.[20]

Fig. 12. In Sand Plain at edge of oak forest in northern part of the Dune Section *Quercus imbricaria* here affords shelter under which many Juniper seedlings are in evidence This will likely become in time a dune capped by Junipers

Towards the northern part of the Dune Section the Blowouts are soon occupied by the *Arctostaphylos-Juniperus* Heath Formation as described for the dunes although here perhaps somewhat more vigorous than on the dunes; due perhaps, to the some-

20. Cowles, H. C. l. c. Bot. Gaz. 27 : 173–175. Fossil Beaches.

what more sheltered position. Among the secondary species are a few not found in the formation as it appears on the dunes. One plant of *Juniperus nana* appears here, this being probably the extreme southern range of the species, so far reported for America, excepting certain distinctly alpine stations.

In the vicinity of the Lake Laboratory there is a blowout vegetation of a distinctly different character from that of the heath occupying the blowouts farther to the north. Apparently due to the deciduous character of the dune vegetation in the southern part of the Dune Section the blowouts are more pronounced, and, in fact, the dunes are often completely destroyed by the undermining of the sand by a deep adjacent blowout.

FIG. 13 Juniper-capped dune to the north of the Laboratory. The blowout which includes some "fossil beach" has *Panicum virgatum*, *P scribnerianum*, *Andropogon*, *Salix interior*, *Lepidium virginicum*.

In many cases the sand has been blown away so that the former beach has been again exposed (fossil beach) and in one blowout to the south of the Laboratory there has been either a wind excavation below the normal Lake level or the water has risen into the bottom of a deep blowout, and there has been initiated there a small lagoon succession

The blowout vegetation near the Laboratory may probably be best regarded as an extension of the *Artemisia-Panicum* Sand Plain Formation. The same facies are in evidence although the relative importance of the secondary species is considerably different. *Salix interior* and its variety *wheeleri*, *Euphorbia poly-*

gonifolia, and *Oenothera oakesiana* are here more important vegetational elements than they are in the true Sand Plain. The successional stages following such a blowout formation are not clear; generally with the constant shifting of the sand the blowout is filled up with sand before a succeeding stage can become of importance. Perhaps, as in the case of the heath, the oak forest may be able to take possession without the intervention of a thicket stage.

FIG. 14. Juniper-capped dunes north of the Lake Laboratory. The blowout has *Panicum*, *Andropogon*, *Artemisia*, *Salix interior*. At base of dune at extreme right is a small patch of *Arctostaphylos uva-ursi*'

To the north of the Laboratory a short distance the dunes are mostly capped by good sized Junipers and it is plainly to be seen (Figs. 13 and 14) that with the death of these plants the dunes will be quickly destroyed. This locality must in the not distant past have been occupied by an *Arctostaphylos-Juniperus* Heath Formation, but with some sort of a change in the environment the conditions have become such that the deciduous dune and blowout formations have advanced towards the north, the *Juniperus*-capped dunes thus being remnants of a former heath. Possibly the reproduction of Junipers under the protection of vegetation other than the heath, as in Fig. 12 under *Quercus imbricaria*, may be concerned prominently with such conditions.

In the immediate vicinity of the Laboratory there has been initiated a secondary *Catalpa* Blowout Formation by the planting of a considerable grove of Catalpa seedlings for commercial purposes, but, nevertheless, constituting an ecological experiment of more than passing interest. It is too early to yet predict as to the outcome but it appears probable that the trees will succeed if their roots can once become established in lower layers of sand with abundant and never failing ground-water near at hand If successful and permitted to reach considerable size, dune formation will likely take place on a rather extensive scale and eventually, if allowed to run its course, the place would become an elevated more or less level area with a *Quercus velutina imbricaria* Forest Formation such as in the area now occupied by the buildings of the pleasure resort.

FIG. 15. Secondary *Catalpa* Blowout Formation showing dead plants where the sweep of the wind has induced excessive transpiration.

THE BAY-MARSH-WET MEADOW-THICKET-FOREST SUCCESSION.

Along the western side of the peninsula the vegetational structures represent a variety of conditions of environment which may be classed in a general way under three heads:

1. The Beach Habitat. This habitat includes those portions of the shore which are exposed fully to the action of the surf and from which the water deepens outwards with comparative rapidity.

2. The Marsh Habitat. This habitat comprises those portions of the shore which are comparatively free from the action of violent surf and from which the water deepens outwards from the land very slowly.

3. The Cove Habitat. This habitat comprises those portions of the Bay which are enclosed by peninsulas, etc., in such a manner as to be protected from the action of currents and surf, and in which the water is several feet at least in depth.

The Beach Habitat.

This structure is practically the same beach as is to be found along the Lake shore of the peninsula, although less strongly developed. It has also the same vegetational formations somewhat less well developed and so will not need here a separate discussion. This habitat comprises much of the western shore of the peninsula, northwards from the end of the small peninsula at the entrance to Biemiller's Cove.

The Marsh Habitat.

This structure is exceedingly well developed between the Bar Section of Cedar Point and the mainland to the south and west, embracing altogether hundreds of acres of pure marsh. From Moseley's researches it appears certain that portions of this marsh have remained marsh for hundreds of years, the accumulation of vegetable debris, transformed into muck, having been so nearly equal to the cumulative rise of water that the marsh vegetation has been able to successfully hold the habitat against all invaders for a very long period. It is further to be remembered that this area was formerly a part of the mainland and at one time covered with forest which was eventually killed by the rise of the water, the marsh then taking its place, perhaps an intervening thicket first appearing. The retarding of the currents of the streams entering the marsh at the present and the occurrence of marsh thickets and pure marshes along the retarded and widening stream are at present indicative of the method of origin of the marsh.

The structure of the vegetation in the Marsh Habitat may be analyzed thus:

a. The *Scirpus* Formation,
b. The *Phragmites-Typha* Marsh Formation,
c. The *Salix discolor-lucida* Thicket Formation,
   or the *Calamagrostis* Wet Meadow Formation,
d. The *Rhus hirta* Thicket Formation,
e. The *Ulmus-Acer* Forest Formation.

The *Scirpus* Formation.

This formation is nearly related to the *Typha-Scirpus* formation of the Lagoon Succession but, as we have pointed out for Presque Isle, there is a separation of the two species of that formation when the conditions of the Marsh Habitat are attained. *Scirpus validus* and *Scirpus americanus* are morphologically so constructed as to have a life-form very little affected by surf,

the long, cylindrical, stiff, but yet quite flexible, stems being admirably adapted to withstand surf conditions in which the larger, less flexible leaves and stems of *Typha* with a greater surface exposed to the action of the surf, would be broken up and the plant killed. Accordingly we find that part of the marsh exposed to the action of the surf to have the following structure:

Facies: *Scirpus validus*,
Scirpus americanus.

Principal Species: *Dianthera americana*.

Within the formation there is a distinct zonation, the *Scirpus validus* Consocies occupying the deeper water, often to a depth of four or five feet, while the *Scirpus americanus* Consocies occupies the shallower portion of the habitat, often extending, where the bottom is sandy, out to the water's edge or even onto the wet bank, but on a muck bottom it is usually replaced in water a foot or less in depth by the formation next described. The action of the surf is considerably diminished by stretches of this formation and quite considerable quantities of shifting sand may be stopped and accumulated by the rushes, thus building up the land.

The *Dianthera americana* Society occurs in a few places in the habitat of the *Scirpus americanus* Consocies, being best developed on sand-bars or islands submerged a few inches and over which which there is usually more or less of a current,—practically the condition of a river sand-bar where this plant reaches its best development. The submerged bar along the south side of the entrance to Biemiller's Cove shows this Society very nicely.

With the accumulation of sand and the consequent shallowing of the water, often also with the accumulation of more or less well defined deposits of partially humified muck, the following formation succeeds the *Scirpus* Formation:

The *Phragmites-Typha* Marsh Formation.

Facies: *Typha latifolia*,
Phragmites phragmites.

Secondary Species:

Zizania aquatica,	*Scirpus americanus*,
Sagittaria latifolia,	*Persicaria laurina*,
Sparganium eurycarpum,	*Calamagrostis canadensis*,
Solanum dulcamara,	*Naumbergia thyrsiflora*,
Nymphaea advena,	*Dulichium arundinaceum*,
Lemna trisulca,	*Wolffia columbiana*,
Carex aquatilis,	*Carex comosa*,
Salix sp.,	*Cephalanthus occidentalis*,

Many of the secondary species of this formation are more or less temporary invaders belonging more properly to other formations. The larger part of the formation is made up of the

facies alone, the *Typha latifolia* Consocies being found in the deeper water and in perhaps more exposed positions than is the *Phragmites phragmites* Consocies.

The immense accumulation of muck underlying this marsh is likely the product of the accumulation and subsequent more or less complete humification of the remains of the plants of this formation. The annual growth of these plants constitutes a large quantity of vegetable matter which, upon its death, is placed in most favorable conditions for its retention and subsequent humification. In places where the accumulation of humus has been so rapid as to raise the level of the soil above the water or, as along the edge of the Bar Section, where sand drifts in and helps to build up the soil, there follows a succession by either the *Calamagrostis canadensis* Wet Meadow Formation or by the *Salix discolor-lucida* Thicket Formation.

FIG. 16 The Black Channel and the *Phragmites-Typha* Marsh Formation. The forests in the far distance are at the edge of the mainland on the other border of the marsh more than two miles distant

The *Salix discolor-lucida* Thicket Formation.

There are no very well marked examples of this formation and its structure is not clear to the writer. However, the structure has been correlated with a similar and well-marked formation at Presque Isle, and in the limited areas where it occurs along the Bar Section it agrees well with the Presque Isle formation. It possibly may prove to be the same structure as was called the

"*Salix sp.*" Formation around the lagoon at the northeast corner of the peninsula. As exemplified along the Bar the structure is as follows:

Facies: *Salix discolor,*
Salix lucida,
Salix amygdaloides.

Principal Species: *Solidago canadensis.*

Secondary Species:

Salix cordata,	*Lycopus americana,*
Cornus amomum,	*Cornus stolonifera,*
Rhus hirta,	*Rosa carolina,*
Cephalanthus occidentalis,	*Cicuta maculata,*
Epilobium adenocaulon,	*Mimulus ringens,*
Impatiens biflora,	*Stachys aspera,*
Teucrium canadense,	*Thaspium barbinode.*

The conditions of environment brought about by a rise in water level are such that xerophytic soil with little humus rapidly passes through the mesophytic to the hydrophytic stage and this is evidently not so well suited to the *Salix discolor-lucida* Thicket Formation as is a similarly situated, humus-rich soil, which, with the elevation due to the accumulation of vegetable humus has passed from hydrophytic to more mesophytic edaphic conditions, as is ordinarily the case around marshes and ponds.

In a few places this shrub formation alternates with the *Calamagrostis* Wet Meadow Formation, but, as this is of comparatively limited extent as compared with the wet meadow occurring in connection with the Cove Habitat near the Laboratory, a discussion of its structure will be taken up under the treatment of the Cove Habitat.

The *Rhus hirta* Thicket Formation.

This formation is sparingly developed along the marsh shore of the Bar Section but it is comparatively not vigorous and does not form areas of any considerable size. It sometimes borders the preceding shrub formation (*Salix discolor-lucida* Thicket Formation) or the wet meadow formation, or it may directly adjoin the *Phragmites-Typha* Marsh Formation. In many places there is a direct transition from the Sand Plain of the Bar Section to the Marsh Formation with no intervening shrub or meadow zone.

The cottonwoods in the Bar Section are not of great age and they have undoubtedly been such as have accomplished ecesis in the edge of the marsh where the disseminules were buried under the indrifting sand; conditions almost identical with those obtaining along the wet bank of a newly formed beach lagoon.

In a few places towards the Dune Section *Ulmus americana* seedlings were found along the shores of the marsh under such con-

ditions as would indicate a possible *Ulmus-Acer* zone as a successor to the shrub zone providing other conditions do not prevent their development. However, if the trend of environmental conditions is to continue indefinitely as in the past there is little probability that this forest zone will be able to mature.

The Cove Habitat.

The Cove Habitat and its vegetation is one of the most marked ecological features of Cedar Point. The completeness of the vegetational structure and the size of the habitat, as exemplified in Biemiller's Cove and in other coves to the south of the Laboratory, are far in advance of anything in this line at Presque Isle and to say the least, the student of cove vegetation will find here exceptionally fine opportunities for such studies. Proceeding from the deepest water towards the shores the general structure of the vegetation may be classified as follows:

a. (The *Chara* Formation.)
b. The *Potamogeton* Formation,
c. The *Castalia-Nymphaea* Formation,
d. The *Phragmites-Typha* Marsh Formation,
e. The *Calamagrostis canadensis* Wet Meadow Formation,
f. The *Cephalanthus-Cornus* Thicket Formation,
g. The *Rhus hirta* Thicket Formation,
h. The *Ulmus-Acer* Forest Formation.

The *Chara* Formation.

A few specimens of *Chara* were found at Presque Isle in situations similar to the Cove Habitat at Cedar Point and Pieters reports more or less complete *Chara* associations in the western end of Lake Erie and in Lake St. Clair, although seldom found where the bottom was sandy.[21] Probably with proper facilities a search of the coves of Cedar Point would reveal a more or less well developed *Chara* formation; although generally sandy, the cove bottoms are not altogether so.

The *Potamogeton* Formation.

This formation is particularly well developed here and, in general, it very closely resembles the corresponding formation at Presque Isle. Its habitat may be said to comprise that part of the cove in which the water is four feet or more in depth, excepting in the deepest portions where the *Chara* Formation may be more characteristic. The coves are likely nowhere so deep as to exclude the latter formation. The structure of the *Potamogeton* Formation is essentially as follows:

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21. Pieters, A. J. The Plants of Western Lake Erie with Observations on their Distribution. U. S. Fish Commission, Bull. 1901 : 57-79. and The Plants of Lake St. Clair. Bull No. 2, Michigan Fish Commission, 1894.

Facies: *Potamogeton perfoliatus,*
Potamogeton lonchites,
Potamogeton pusillus.

Principal Species:
Vallisneria spiralis,
Myriophyllum spicatum.

Secondary Species:

Potamogeton natans,
Potamogeton amplifolius,
Naias flexilis,
Castalia tuberosa,
Scirpus validus,
Ceratophyllum demersum
Potamogeton foliosus,
Potamogeton zosteriaefolius,
Philotria canadensis,
Nymphaea advena,
Nelumbo lutea,

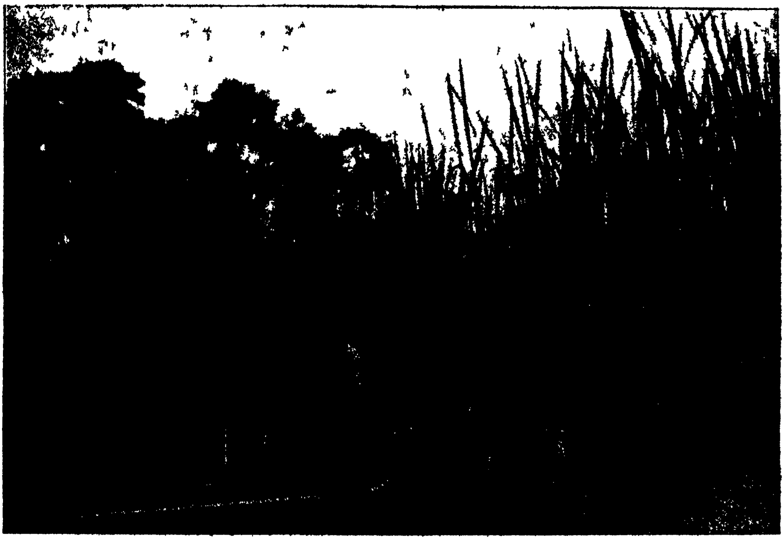

FIG. 17. A *Pontederia cordata* Society along the submerged bar at the south end of Biemiller's Cove The *Typha latifolia* Consocies of the *Phragmites-Typha* Marsh Formation in the background.

The mass of vegetation comprising this formation is altogether quite large and the water is often so thoroughly filled up with it that, looked at from above, the space appears completely taken up by the vegetation in the middle and lower depths. The conditions are very good for the accumulation of considerable deposits of vegetable debris and for straining out suspended sediments in the water, or for obstructing to some extent floating debris, so as to finally lead to its deposition on the bottom. Under conditions of stable equilibrium, as to the relative position of water level and the land, this formation could be expected

in the course of time to build up the bottom to such an extent as to eventually lead to the invasion and occupation of the habitat by the formation to be next described

The *Castalia-Nymphaea* Formation

This formation also is well developed in the Cedar Point coves It occupies a zone next outside of the *Potamogeton* Formation in water of a depth of from one or one-and-one-half feet to four feet In its outer deeper part it is always much mixed with the *Potamogeton* Formation but aside from that it is a well defined and vigorous structure.

Facies. *Castalia tuberosa*,
Nymphaea advena,
Nelumbo lutea

Principal Species: *Pontederia cordata*,
Utricularia vulgaris,
Zizania aquatica.

Secondary Species:
Potamogeton natans,
Potamogeton pusillus,
Myriophyllum spicatum,
Sagittaria latifolia,
Naias flexilis,
Typha angustifolia,
Batrachium longirostris
Potamogeton lonchites,
Bidens beckii,
Philotria canadensis,
Sagittaria graminea,
Typha latifolia,
Phragmites phragmites,

FIG. 18. The *Nymphaea advena* Consocies, here mingled with the *Castalia tuberosa* Consocies, in the second cove south of Biemiller's Cove. *Typha* in the immediate background and *Phragmites* farther back.

The facies of this formation exhibit more or less zonation. *Castalia tuberosa* generally forms a Consocies in the deeper part of the habitat of the formation while the shallower part of the formation often has alternating *Nymphaea advena* Consocies and *Nelumbo lutea* Consocies. Over a large part of the habitat, however, the facies are mingled to such an extent that the consocies structure is not evident.

The *Pontederia cordata* Society is not ordinarily of large extent but the plant usually appears in dense ecological families and communities. This Society is usually associated with the *Nymphaea advena* and the *Nelumbo lutea* Consocies in the shallower water of the habitat.

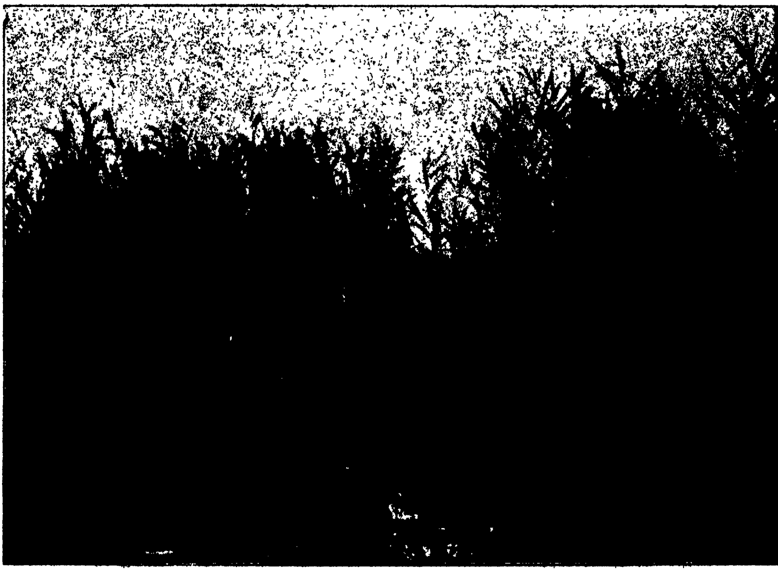

FIG. 19. The *Nelumbo lutea* Consocies mingled in the left background with the *Pontederia cordata* Society. The general background being the *Phragmites phragmites* Consocies of the Marsh Formation. In the third cove south of Biemiller's Cove.

The *Utricularia vulgaris* Society determines a quite conspicuous aspect in midsummer in some of the little bays and inlets opening off from the larger body of the cove into the marsh,—usually in water of not more than six or eight inches in depth with a deep semi-liquid muck bottom.

The *Zizania aquatica* Society determines a conspicuous autumnal aspect almost throughout the whole formation except, perhaps, in the very deepest part. During midsummer this

structure only begins to show, but at the fruiting season of the wild rice the habitat of the *Castalia-Nymphaea* formation is conspicuously dominated by the Society.

The *Phragmites-Typha* Marsh Formation.

In the more sheltered habitat afforded around the cove this formation differs from the formation as found in the marsh to the west of the Bar Section in that the *Typha latifolia* Consocies is more prominent. It appears from the writer's observations that the *Typha latifolia* Consocies prefers a soil rich in humus while the *Phragmites phragmites* Consocies, other conditions being

FIG. 20. The *Utricularia vulgaris* Society in one of the larger inlets running into the marsh at the north end of Biemiller's Cove. *Typha latifolia* and *Typha angustifolia* Consocies in the background. *Scirpus americana* at the right.

equal, prefers a more sandy substratum. On the submerged sand bar which forms the southern boundary of Biemiller's Cove the axis of the bar where about a foot under water is occupied by the *Phragmites phragmites* Consocies, while towards the junction of the bar with the mainland, where there is considerable humus in the soil, the *Typha latifolia* Consocies appears.

The composition of the formation as exemplified around the coves is as follows:

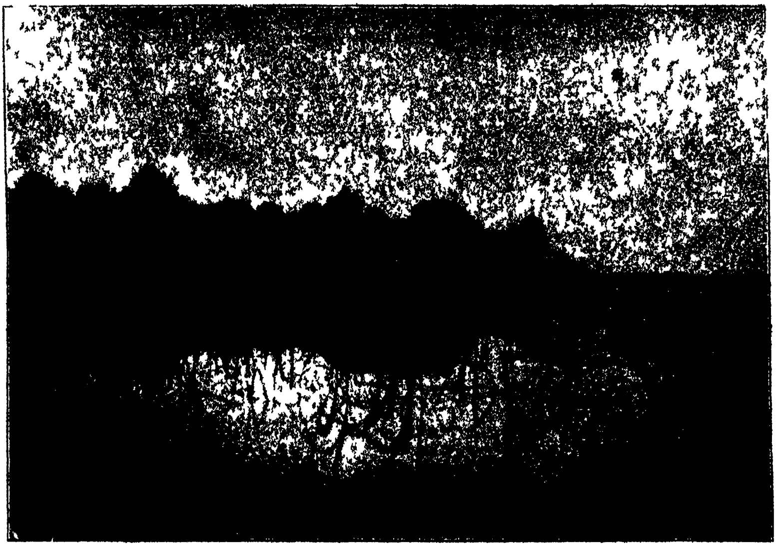

FIG 21 In fourth cove south of Laboratory, photo taken in late August shows the *Zizania aquatica* Society beginning to appear.

FIG 22 Looking northwest across the northern part of Biemiller's Cove and the adjoining marsh *Castalia-Nymphaea* Formation at left in cove *Typha latifolia* and *Typha angustifolia* Consocies comprise most of marsh The narrow peninsula in distance occupied by the *Ulmus-Acer* Forest Formation Photo taken from roof of Laboratory.

Facies: *Typha latifolia,*
Typha angustifolia,
Phragmites phragmites.
Principal Species: *Hibiscus moscheutos.*
Secondary Species:

Zizania aquatica,	*Dianthera americana,*
Sagittaria latifolia,	*Sparganium eurycarpum,*
Lemna trisulca,	*Dulichium arundinaceum,*
Naumbergia thyrsiflora,	*Persicaria laurina,*
Cornus amomum,	*Cornus obliqua,*
Cephalanthus occidentalis,	*Carex comosa,*
Cicuta maculata,	*Solanum dulcamara,*
Calamagrostis canadensis,	*Carex comosa.*

This formation, with the building up of the soil above the water level, may give way immediately to a shrub formation but, where there is a considerable extent of wet soil just above the level of the water, there is more likely to be an invasion and subsequent occupation by a wet meadow formation, as follows,—typically exemplified at the eastern border of the marsh to the north west of the Laboratory:

The *Calamagrostis canadensis* Wet Meadow Formation.

Facies: *Calamagrostis canadensis.*
Secondary Species:

Blephariglottis psycodes,	*Bidens discoidea,*
Boltonia asteroides,	*Campanula uliginosa,*
Carex schweinitzii,	*Carex comosa,*
Carex frankii,	*Carex lanuginosa,*
Carex stipata,	*Carex tribuloides,*
Carex bicknellii,	*Carex lupulina,*
Carex laxiflora,	*Carex vulpinoides,*
Cephalanthus occidentalis,	*Cornus amomum,*
Cornus obliqua,	*Sambucus canadensis,*
Dryopteris thelypteris,	*Epilobium adenocaulon,*
Lobelia syphilitica,	*Lathyrus palustris,*
Gyrostachys cernua,	*Mimulus ringens,*
Penthorum sedoides,	*Onoclea sensibilis,*
Roripa hispida,	*Roripa palustris,*
Rumex crispus,	*Rumex verticillatus,*
Rumex obtusifolius,	*Salix cordata,*
Salix amygdaloides,	*Salix lucida, etc.*

The list of secondary species in this formation is a very long one, especially when including various invading species from the other formations adjacent, and certain other more or less ruderal species. However, in the real vegetational structure these many species play very little part, the facies constituting almost entirely the bulk of the vegetation.

This formation is apparently a rather rapid soil-former and with the elevation of the ground the more mesophytic conditions permit the entrance of the following thicket formation, as around the east side of the area of the *Calamagrostis* Wet Meadow to the northwest of the Laboratory:

The *Cephalanthus-Cornus* Thicket Formation.

Facies: *Cornus amomum*,
Cornus obliqua,
Cephalanthus occidentalis,
Rosa carolina.

Principal Species: *Sambucus canadensis*.

Secondary Species:

Salix cordata,	*Salix amygdaloides*,
Salix lucida,	*Calamagrostis canadensis*,
Polygonum convolvulus,	*Solanum dulcamara*,
Dryopteris thelypteris,	*Platanus occidentalis*,
Ailanthus glandulosa,	*Ulmus americana*,
Rhus hirta.	

This vegetation should be classed rather as a mixed formation, perhaps, than as a pure one, it apparently being made up of various elements from the other thicket zones on the peninsula. The predominating consocies is the *Cornus amomum-obliqua* Consocies, while during the flowering period of the elderberry the *Sambucus canadensis* Society determines in places a conspicuous aspect.

Along the eastern shore of the marsh and wet meadow formations forming the northward extension of Biemiller's Cove, considerable sand has blown over in places from the peninsula and the bank rises in such places quite abruptly. At such points the *Rhus hirta* Thicket Formation usually occupies this more xerophytic habitat and it, evidently, under such conditions, is succeeded by the *Quercus velutina-imbricaria* Forest Formation.

Where the slope is more gradual, with a more hydrophytic soil, usually also with more humus, the normal succession appears to be from the wet meadow through the *Cephalanthus-Cornus* Thicket Formation to the *Ulmus-Acer* Forest Formation.

The *Ailanthus glandulosa* Forest Formation.

An interesting example of an anomalous succession is afforded in the near vicinity of the Laboratory and at a couple of other stations on the peninsula by the *Ailanthus glandulosa* Forest Formation which is rapidly developing along the shores of the cove and Bay in the Dune Section. This Asiatic ruderal tree now constitutes a prominent zone occupying the habitat of the less hydrophytic of the thicket zones, although often displacing

also the *Cephalanthus-Cornus* zone and extending, as well, up the sides of adjacent dunes and onto the adjacent *xerophytic* Sand plain.

Although very successful in competition with the *Cephalanthus-Cornus* and *Rhus hirta* Thicket Formation, it appears probable that this formation will eventually be succeeded by the *Ulmus-Acer* Forest Formation. The structure of the *Ailanthus glandulosa* Forest Formation, as to the lower layers, is intermediate generally between that of the thicket formations that have been supplanted and that of the *Ulmus-Acer* forest. A number of the species, such as *Campanula americana*, belong more especially to the latter formation, but the conditions of dense shade of the Ailanthus forest seem to have supplied the conditions essential for its entrance into this habitat.

Certain secondary successions are to be seen in several places on Cedar Point, as brought about by the agency of man, but these were not studied in detail by the writer. One of these successions has been brought about by the effort made to have a lawn and shrubbery in the vicinity of the buildings of the Pleasure Resort. Another secondary succession marked by the appearance of a number of ruderal species has been brought about by the throwing aside of sand in connection with the dredging of the artificial "Lagoons."

Carnegie Museum, January 20, 1908.

THE MURMAN BIOLOGICAL STATION.

Sergius Morgulis.

To the observer abroad, in Europe and more especially in America, Russia is still vested with clouds of mystery. This is true even with regard to the scientific Russia, slightly known in other countries, which of course is due primarily to the Russian language being familiar only to very few scientists.

This note is intended to acquaint the reader with a neglected scientific institution, of no small rank, and is compiled largely from reports kindly placed in my possession by Dr. K. M. Derjugin, Curator of the Station.

Marine Biological Stations are the workshops of biologists, and ever since students of nature have abandoned their air-tight laboratories, stored up with pickled specimens, and migrated to the shores of the open sea, where they came in direct touch with an exuberant living world, our science has progressed by strides. This "migratory humor" effected also the Russian biologists, and the famous embryologist Kovalevsky succeeded in founding a Biological Laboratory on the coast of the Black

Sea, which soon became an important center for research work in Russia, and gained a world-wide reputation.

We cannot, however, say the same thing about the Murman Biological Station, established only in 1899, as yet very little known, and which, by the way, is often confounded with its unsuccessful predecessor, "The Biological Station of the Solovetsky Monastery."

The history of this Murman Station presents a few interesting features, so characteristic of every Russian "history." In 1882 Prof. Wagner, of the St. Petersburg University, was allowed to carry on investigations on the northern fauna in a fisherman's hut, belonging to the Solovetsky Monastery. This permission he obtained through the courtesy of the Father-superior of the Monastery, which is situated on the Solovetsky Islands, in the middle of the White Sea, a relatively short distance from the Arctic Ocean. Year after year, during the summer months, this fisherman's hut was visited by investigators who studied the rich animal and plant world of this region In the meantime, the fisherman's hut has undergone considerable change. A few new buildings were added to it at the expense of the Society of Naturalists, and it was made more suitable for scientific work.

After a seventeen years' fruitful existence the laboratory had to be abolished on these islands. The death-blow to the young and growing institution was dealt by the new father-superior of the monastery who denounced the scientific visitors of these islands in his secret report to the office of the Holy Synod, by lodging a complaint that the presence of "impious" scientists acts demoralizingly upon the monks and pilgrims. The father-superior's argument produced its effect, and the nature-students soon packed up their luggage and started out in search for a new settlement in that cold region. Such has been found on the Murman Peninsula where the present Murman Biological Station was established in 1899, and has operated successfully since. They have fairly well equipped laboratories there, aquarium rooms, museum, a reference library containing a few hundred volumes, etc. The station is situated in an attractive rocky locality right on the shore of the Kolsky Bay.

The climate of this region is rather cold, the average yearly temperature not being above 0 degrees Centigrade, but July and Auguts are very comfortably warm months. The flora and fauna is very rich there, and as Prof. Derjugin tells me, there is hardly a case when the dredge does not bring up a multitude of various organisms. There have been listed over 500 representatives of all the classes of invertebrates and fishes, and Hydrozoa, Actinozoa, sea-urchins, star fishes, worms, planarians, nemertines, molluscs, crustaceans, are all very abundant, and their eggs can

also be obtained easily. Besides, there is an abundance of fresh- and brackish-water animals and plants as well as numerous land forms. Up to 1905 there had been at the laboratory about fifty investigators, instructors and students of various universities, and some thirty-five publications have been based upon materials collected and studied there. No special fee is imposed for the occupation of tables, and glass-ware, instruments and reagents, except the very expensive ones, are also allowed free of charge.

The student who goes abroad to spend the summer in research work, ordinarily goes to places where the sea is blue and the sky is hot, and it never occurs to anyone to visit the far north, and especially Russia. We shall, however, give a few hints of information as to how this remote station may be reached for the benefit of those who may experience the desire to study the northern fauna. The best way would be to go from Petersburg to Archangelsk by railroad, and then by steamer to Alexandrovsk where the station is located. The trip from Petersburg, affording a splendid opportunity to observe the northern part of Russia, is very inexpensive, and taking into consideration that there is no laboratory fee, and that living expenses are also very small, it does not involve any difficulty from a financial standpoint. A little knowledge of German, or perhaps still better, of French, will enable one to evade the difficulty which the Russian language presents. We feel sure that anyone visiting this place will carry off with him a pleasant recollection of the hospitality extended to him with the characteristic Russian cordiality.

Meeting of the Biological Club.

The Club met in Orton Hall March 2d, 1908. Dr. Hubbard presided. After the reading and approval of the minutes of the previous meeting, F. Carty, Fred Marsh and Stanley Hart were proposed for membership.

The paper of the evening was presented by Miss Freda Detmers. This paper was entitled, "A Month's Visit to Southeastern Alaska." It was illustrated by lantern slides, and many fine views of the glaciers, vegetation, towns and inhabitants were given. The vegetation in this far northern region presents some interesting phases of plant life, one of the most abundant species being the fire weed. The meeting was the best attended of the year, over fifty being present. Miss Emily Hollister was elected to membership, after which the society adjourned.

ARTHUR H. McCRAY, Secretary.

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TYPE AND VARIABILITY IN THE ANNUAL WOOD-INCREMENT OF ACER RUBRUM L.

ALFRED DACHNOWSKI.

In all temperate zones, at least, trees form annually one layer of wood, which appears on a cross-section of a tree as a ring, more or less clearly defined. The rate at which the diameter and the area of any cross-section of the tree increases, can therefore be easily ascertained by measuring the width of the rings. To obtain direct evidence as to the relation of the rate of wood formation to the nature of the habitat, and to obtain information on the value of a biometric study in differentiating such habitats, statistical work has been carried out during the past winter of 1907-8. The work was done in connection with an inquiry on the toxic properties of bogwater and bogsoils, the data of which, correlated with this and other studies, will be brought out elsewhere in another paper.

The purpose of the article here briefed is to call attention to the fact that statistical methods first used by Galton and now applied by Pearson (7), Davenport (4), Shull (8), and others to the more complicated questions in variation and heredity, may be of service also in Forestry problems as well as in questions of Ecology.

About 25 miles east of Columbus occurs an extensive lake, approximately ten miles long and one mile wide, known as Buckeye Lake. Near the northern bank, and midway between the small towns of Lakeside and Avondale is a bog-island very nearly one-tenth the dimensions of the lake. Soundings made to determine the character of the peat gave 30 to 40 feet as the depth of the island. Its vegetation presents two well-marked zones,—a central one consisting of Sphagnum, Carex, Eriophorum, Oxycoccus, Drosera, Rhus vernix, Aronia nigra, and others, and a marginal zone which includes besides several species of Salix, Alnus incana, A. rugosa, Ilex verticillata, Cornus

canadensis, etc., a few small oaks, and Acer rubrum as the dominant form. An interesting comparison is afforded when we note that the country surrounding the lake and especially the northern shore near the bog-island supports at various places a forest vegetation in the form of woodlots. The most common trees are the beech, elm, maple, oak, chestnut and walnut,—examples of a temporary mesophytic climate society.

In determining the influence on annual accretion of wood the stumps of red maple were selected. A number of these trees had been just recently felled both in the bog and on the shores near by. It seemed desirable therefore to procure and record data on measurements from such trees of the two conditions of habitat, as were nearly the same in size, age, uniformly concentric growth of wood, and general environment. The general climate is assumed to be almost identical for both places, and being thus eliminated, it became more easy to determine the effect of edaphic conditions upon the rate of diameter growth of the species.

From the number of trees at disposal five were selected from the marginal bog-zone, and three were chosen from the woodlots near the shore. It may be objected that not enough trees were analyzed to permit the conclusion drawn. In order to eliminate sources of error, measurements were made, indeed, on a larger number of sample trees. To the writer, however, it seemed that the degree of confidence and the accuracy of the statistical result depended not so much upon numbers, as upon the functional criteria of the environment. It was not so much the object of this study to establish variability, as to find a suitable method of determining the influence of various factors in the environment. A method was sought by which temperature, light, humidity and soil data could be combined in a single number. The fact that so large a part of plant activities and adaptation is directly or indirectly connected with climatic and edaphic factors, suggested that if a comparative and statistical study of secondary growth on similar trees of various pronounced habitats were made, a new basis for determining climatic and edaphic regions of optimum development would be at hand.

Put in tabular form the results of the measurements are as follows:

Width of Rings in mm.	1.	1.5	2.	2.5	3.	3.5	4.	4.5	5.	5 5	6.	6.5	7	7.5	8	8.5	9.	9.5	10.	Tot.
Frequencies in Bog habitat	16.	10.	23.	20.	27.	12.	20.	5.	7	5.	5.	5.	6	1.	2.	0.	1.	0.	2.	167
Frequencies in Woodlots	26.	30.	31.	9.	6.															102

These frequency distributions are shown graphically in Fig. 1. The abscissæ give width in millimeters, the ordinates frequencies of rings. The variation constants deduced from them are indicated on page 347.

For the benefit of those unfamiliar with the biometric method of study employed here, a brief discussion of the more salient points is appended. For a more complete statement the reader is referred to Davenport's "Statistical Methods" (4) or the more popular work of Pearson (6).

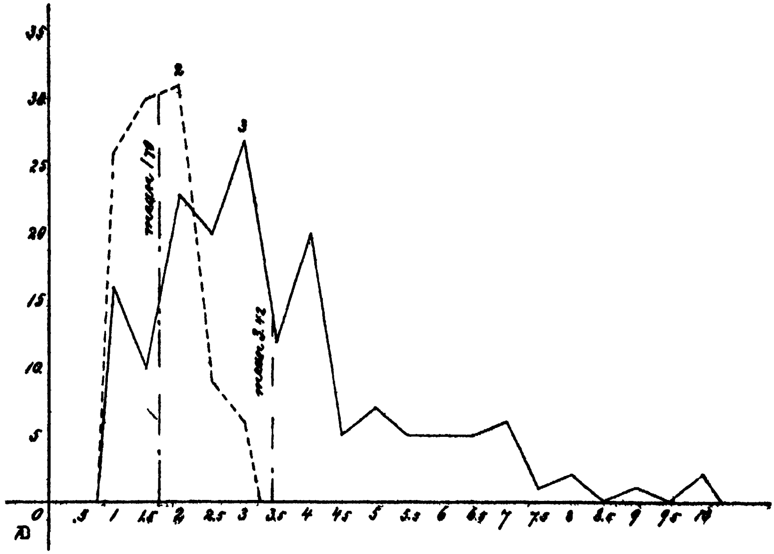

FIG 1—Frequency curves showing variation in width of the annual wood-increment in Acer rubrum. Continuous lines—bog habitat; Dotted lines—woodlot habitat

It will be noted that in the trees of the bog habitat, there are more rings three mm. long than of any other length, while in the second type of habitat the greater number of rings has shown two mm. This highest frequency or most common length is known as the mode. It shows clearly the prevailing *type* of wood-accretion. The distribution decreases in both directions from the mode, but least so in the woodlot habitat. The practical importance of the information afforded by this value is apparent. We have here the average prevailing state or place-habit of a similar lot of individuals from two distinct places. It is a characteristic which has been determined by influences covering a period of time (the age of the trees) long enough to eliminate the effect of incidental fluctuations in the

habitat. In selecting one character for measurement it must not be forgotten, of course, that the organism is a correlated unit or whole. Change of environment may alter therefore a great variety of characters. Whatever the species, its differences constitute a distribution of deviations extending sometimes through a considerable range. Points such as these the systematist above all, must necessarily consider.

Another conception of the character and the amount of wood-accretion and its distribution is possible through the arithmetical average or mean. Multiplying the value of each variate by its frequency, adding the results and dividing the sum by the total number of rings, we thus get a determination of the mean or average length. In this case the mean length is 3.42 mm. and 1.70 mm. respectively for each of the habitats under consideration. These values differ very sensibly from the most common length or mode. It will be seen at once, that the deviations in excess of the mode are in the case of the bog habitat larger and in the woodlots smaller. The mean is in the latter case less and in the former greater than the respective mode. Such distributions are termed skew,—the mode and the mean are separated from each other by a certain measurable distance. The relative breadth of the curves exhibits to the eye the great variability and the prominent skewness.

There have been various interpretations of skewness, but it is evident that we are dealing here with the results of direct physiological reactions to the changes in the environment. On an average the annual accretion in woodlot conditions is by far less than in the bog habitat. Not all individual trees are alike sensitive to changed conditions, but the greater value of the positive skewness in the bog habitat indicates that only a small proportion of the variates is conservative. It is plain, therefore, that the position of the mode and the negative skewness in the woodlot forms has resulted from physiological variation, i. e. from the prevailing edaphic conditions of that place, and that the differences in the environment have changed the type, the variability and even the sign of the skewness.

The frequency curves enable us to perceive still another relation. It will be observed that some of the rings deviate but little from the mode or the mean, while others deviate more and some even very much. For instance, the deviations from the mean in the frequencies of the woodlot samples are $-.70$, $-.20$, $+.30$, $+.80$, and $+1.30$. The average deviation is omitted here as having no particular significance. Usually a standard deviation is derived in the following manner. The deviation of each frequency from the mean is squared and then multiplied by its corresponding frequency; the products are added and then divided by the total number of variates, and the square root

extracted. The result as corrected by a number representing the probable error is the standard deviation. We thus arrive at a value 1.87 mm. for the bog habitat, and 0.56 mm. for the woodlot habitat, which stands as a definite measure of variability. It enables comparisons from year to year and between different localities, advantages which are too obvious to require elaboration.

To compare variability on an abstract basis an expression combining the idea both of standard deviation and type is added here. It is found by dividing the standard deviation by the mean as a base. The result is an excellent index of variability in the form of a rate percent usually known as the coefficient of variability. The value of the coefficient of variation will change directly with changes of the standard deviation, and inversely with changes of the mean. For the case at hand the coefficient of variability is 54 60 and 33.28 for the bog conditions and the woodlots respectively.

The mode and the three important variations constants, together with the probable errors of the determination, which were deduced from the frequency curves in the manner described above, are as follows:

Habitat	Bog	Woodlots	Difference
Mode	3 mm.	2 mm	1 mm.
Mean	3 425 $\pm$ 0 098	1 701 $\pm$ 0 038	1 72 mm
Standard Deviation.	1 870 $\pm$ 0 069	0.566 $\pm$ 0 027	1 31 mm.
Coefficient of Variability.	54 60 $\pm$ 2 55	33 28 $\pm$ 2 46	21 32

The amount of variation is, as we should expect it to be, sensibly different in each of the localities selected. The extreme values for the coefficients are 54.60 and 33.28 giving a difference of 21.32. We may accept these differences in the coefficients of variability as additional proof that when organisms are introduced in changed or unusual conditions they become more or less variable. It can safely be granted that the conditions of variability which are here a function of place, are masked but little by others. In the case at hand, variability is not due to chance but is an inevitable accompaniment of the differences in the habitat. The evidence for this statement is found especially in a forthcoming paper on the response of plants to toxic bodies, and in the methods and results of experimental physiology (2). Here, however, the results appear to be of

considerable interest as showing that by the use of the quantitative method we are passing to an equally definite and exact determination of the importance of environmental conditions.

The points brought out in this communication may be summarized thus:

(1) The data above presented show clearly that a biometric record of secondary growth in trees furnishes a very valuable criterion for the comparison of the conditions of different plant habitats. They are data involving climatic and edaphic factors which are of the greatest importance to plant life, and hence may be best correlated with functional and structural changes.

(2) The response to environment in the case of Acer rubrum is rapid and pronounced. The annual growth of wood automatically records in duration, intensity and quality the effect of the "various ecological factors working in concert" (3). The differences in amount and size of wood cells, in thickness of walls, extent of infiltration, etc., clearly indicates differences in type.

(3) In a study such as this the biometric data seem more valuable than long records of temperature, light, humidity, wind velocity, and others. The effect of these is included as far as they influence the plant. Greatly varying as meteorological and soil data are, it is indeed almost impossible to combine them so as to exhibit their united action to climatic and edaphic centers of development. Hence the biometric point of view is an additional criterion to furnish a suitable basis for comparing ecological data, and for determining the relation of a locality to the whole range of the species, and to the direction of its migration (1). It seems certain, therefore, that if such statistical data were exhibited for various regions, climatic and edaphic centers of distribution could be clearly indicated (9). It is hoped that investigators in other places will make studies similar to the one here presented for the purpose of testing the value of this criterion.

(4) It is well known that the ability of plants to transmit acquired characteristics is readily demonstrated in forest trees, where climatic influences continue to show themselves with plants grown from seed derived from different localities. It becomes a problem of practical as well as theoretical importance to determine to what extent such distributions in functional variations persist. The advantage of the biometric method to know definitely the behavior of plants and the effect of environment is apparent. Whether or not individuals which have proven to be more variable would be favorable to any selection process remains to be seen from experimental determinations.

Botanical Laboratory, O. S. U. March, 1908.

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STREAM DIVERSION NEAR LAKEVILLE, OHIO.*

GEORGE D. HUBBARD.

The announcements of stream modifications have come to us so often in the last generation that we no longer wonder at them. They are very common and most of the larger streams have been subject to one or more of them. With all the examples which have been described and explained there has come a great variety of form and cause, yet a classification under three heads is possible. Some are simply diversions in which the stream had nothing to do but to get out of the way; these occur most frequently in glaciated regions. Other causes are land and snow slides, lava flows, volcanic eruptions and artificial obstructions. Some are adjustments in which the stream modifies its course or the form of its valley because the one or the other is out of harmony or adjustment with the needs of the stream; these occur in regions where superposition or rejuvenation have occurred and the stream in its later stages is in different rocks from those in which it worked in youth. The third class

*Presented to the Biological Club, February 3, 1908.

is actual piracy, stream robbing or stream capture, and may be associated with superposition of streams or rejuvenation, but is a common accompaniment of crustal tilting or shifting of shorelines.

The case at Lakeville is an example of the first kind, simple diversion, where streams have been forced out of their former courses and have been obliged to pursue new courses ever since.

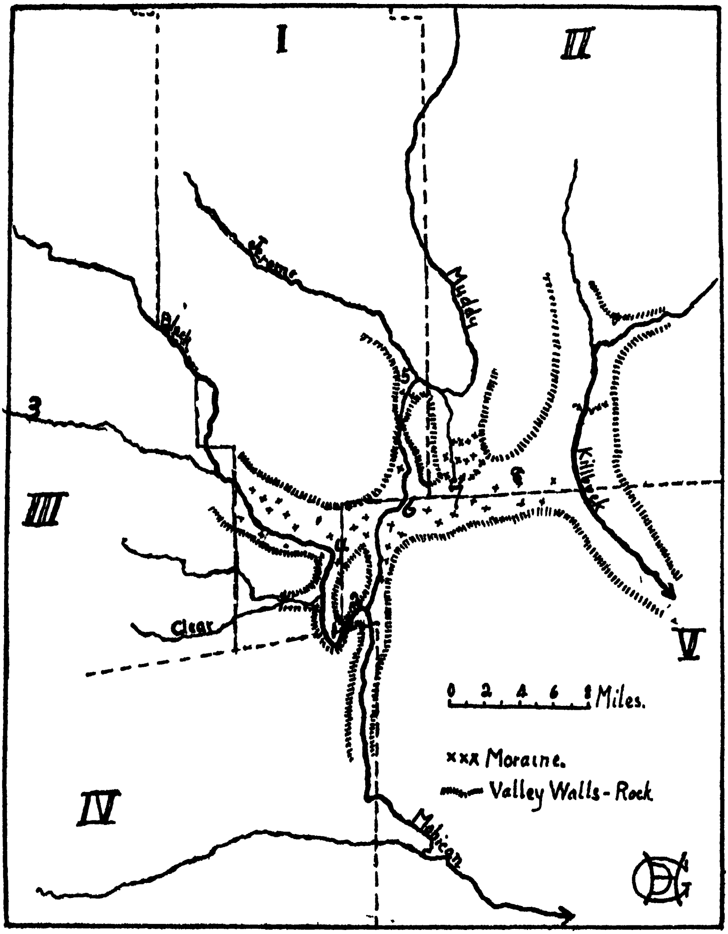

FIGURE 1.
Counties.—I. Ashland, II. Wayne, III. Richland, IV. Knox, V. Holmes.
Towns.—1. Uncas, 2. Spellacy, 3. Mansfield, 4. Loudonville, 5. Lakefork, 6. Lakeville, 7. Big Prairie, 8. Shreve.

I want to examine it as to fact and nature of evidence, and thus discover the cause, treating it as illustrating a method of research rather than as telling of a new kind of phenomenon.

The region is that of the head waters of the Mohican, a stream which unites with Owl Creek to form the Walhonding, which in turn unites with Killbuck Creek and enters the Tuscarawas at Coshocton. The critical places in the case are in southern Ashland County and western Holmes County.

The Mohican Creek proper is made up of the waters of several smaller creeks, Muddy or Lake Fork from the northeast which also brings the waters of Jerome Fork, Black Fork from the nothwest, and Clear Fork from the west, which joins Black Fork just above the narrows at Uncas and Spellacy.

Black Fork comes down from north of Mansfield in a post-glacial valley hitting the rocks occasionally and then leaping over falls and rapids or winding through gorges. Fleming's falls and gorge above Miflin furnish a good example of this habit. But just before entering Ashland County above Perrysville, Black Fork enters a broad, mature, rock valley, more or less plugged with moraine of Wisconsin age and pursues it to Loudonville. Here it abruptly turns into the south wall of the big valley and winds through a six or seven mile gorge into Knox County, where it joins the Muddy Fork and the two constitute the Mohican.

In like manner Jerome Fork heads in post-glacial valleys in the drift of northeastern Ashland County, but before joining Muddy Fork at the town of Lakefork it finds itself in a broad, open, mature, rock valley leading southeast. At Lakefork, having entered Muddy Fork, its waters turn abruptly into the hills and lead southward into a rapidly narrowing valley. The narrowest part is found about midway between Lakefork and Lakeville where the stream seems to have cut a notch in a low mature divide. Below this place, the valley widens southward and emerges into the very broad mature valley, which Black Fork followed seven or eight miles; and the stream, turning westward in the large valley, winds about among morainic hills for some two miles, then turns again into a hill-enclosed narrowing valley and follows it southward through two morainic loops, and on southward to the Mohican, which is said to flow through a narrow valley in a very hilly country. The author has not seen this portion of the Mohican.

A sluggish little branch of Muddy Fork rising among a series of morainic loops northeast of Big Prairie flows through a broad clay-bottomed, level-floored valley for five or six miles and enters the Muddy just before the latter goes into the hills at Lakefork.

Recognizing the fact, as all of us probably do, that valleys are made by streams, and, in similar rocks are proportionate in size and form to the size of the stream and the length of time the latter has had to work, it becomes very apparent that we have an anomalous condition here, where the larger streams Black and Muddy Forks flow in broad open valleys, then in narrow ones and again in broad ones, while some small streams are in much broader valleys than they could possibly have made during the time at their disposal. These are the features that appeal at once to the traveler and invite his attention if not his curiosity.

Upon looking a little more carefully other items in the problem are found. In the course of Muddy Fork from Lakefork village to Lakeville, and of Black Fork from Loudonville to the Mohican, not only do the valleys narrow but the upland topography changes as the narrowest portion of the valley is reached. The high hills become more youthful and draw in closer to the present main valley, suggesting that formerly at these two narrows, streams once headed and flowed away in opposite directions. In accordance with a law of valley development, that youth is more marked near the headwaters, this theory accounts for the more youthful character of the slopes and form of valley at the narrows.

The side streams entering these two sections of the courses of Muddy and Black Forks respectively, have a story to tell. North of the narrows they enter with their small angles down stream contrary to the normal habit of stream arrangement, and south of the narrows they enter in a thoroughly normal manner with the small angle up stream, suggesting that, at present, the flow of the main stream north of the narrowest places is in the reverse direction from that of the stream occupying the valleys when the drainage patterns were outlined, but that in the portions south of the narrowest places, the flow is in the same direction as during the early history of the region.

It has already been suggested that Muddy and Black Forks have cut at their respective narrows new gorges in rock, through what was formerly a low rock divide between small streams flowing in opposite directions. Still further confirmation of this hypothesis is found in the small laterals entering the main stream near the narrows. The side stream entering Muddy Fork nearest Lakefork shows a very little rejuvenation and down cutting in its mature higher valley in order that the stream may enter Muddy Fork at grade. In the case of the side stream next nearer the narrows, the mature valley seems to hang higher above the level of Muddy and to have a deeper recent gorge valley in its bottom. The third and fourth hang still higher and the recent gorges are still deeper. Moreover the mature hanging

valleys enter the main valley essentially at the top of the gorge of the main valley showing that when the rejuvenation occurred, the valley bottoms of laterals and the main valley floors were at accordant levels, just as are those of the present streams. South of the narrows on Muddy Fork similar conditions obtain, and likewise adjacent to the narrows of Black Fork the phenomena of hanging valleys and recent gorges in their floors are repeated.

This whole series of facts makes it very certain that the streams have been diverted from their old courses and forced over low divides and made to flow in new courses. We are ready then to formulate an hypothesis to explain the observed facts. The hypothesis must account for all the facts and be in harmony with the general conditions of this part of the state.

It was pointed out that there were large deposits of glacial drift in several of the valleys in this vicinity. Glacial moraines are especially developed in the large east and west valley from north of Loudonville to north of Shreve, also in the broad valley north of Big Prairie. Neither of these valleys contains a large stream except for short distances while the smaller valleys with relatively less drift contain the larger streams. The slopes of the valley walls are not steep enough for landslides to occur and interfere with drainage and no evidence of landslides was found. No volcanic lava or ejecta occur here. In fact, the glacial drift is the only material found about here which could plug up valleys and divert the streams. But diversion might be caused by tilting and folding of the strata if these had occurred. Folding and faulting sufficient to induce the stream modifications noted are unknown here. Superposition caused by a leveling up sufficient to send streams over hills and cause them to select entirely new courses independent of old courses has not occurred. Moreover the strata are similar sedimentary rocks all through the region so that neither superposition nor change in the character of the rocks encountered as the streams cut down can be used to explain the conditions. Rejuvenation has been considered. There has been no local uplifting that could rejuvenate in some places and not in others as the conditions would require, nor are the results those consequent on broad or general rejuvenation. Streams in isolated areas only are revived and entrenched. By elimination, we are left to the drift as the immediate cause of the obstructions and diversions. A study of the drift shows it to be deposited in loops and curves as if around the ends of ice tongues extending southward along the valleys and against the margins of broader ice lobes, which must then have advanced into the region from the north.

Working out the relations between the theory of ice invasion of these valleys, and the facts observed regarding stream diver-

sions, the following conclusions may be reached. During preglacial time a system of valleys was here developed—valleys which had reached maturity. This maturity was more marked in and near the master valleys but became less and less strong as one pushed back up the little valleys. Many of the latter, especially south of the large east and west valley, gradually widened northward showing that the line of headwater divides must have lain near but south of this large valley.

The advancing ice would move more easily into the broad, mature valleys and into those lying more nearly in the direction of ice movement. The ice pushed in from the north, as it came into rougher and rougher topography it broke up into tongue-like dependencies,* which extended into the valleys. While the ends of the tongues were fairly stationary, melting freed rock waste which accumulated in moraines. Any stream flowing toward the advancing ice would of necessity find its course closed during the ice advance by ice and moraine. The water, augmented by the melting of the ice, would accumulate in a lake between the advancing ice on the north, the valley walls on the sides and the divides on the south. Its outlet would be over the lowest places, whether of moraine or rock, whether in valleys or over low cols between ridges at the very heads of the streams. Thus was begun the discharge of water over the divides. As the ice continued to advance it crossed one of the divides and may have lowered it some by ice erosion, but this if done, is not very apparent.

While the ice front lay along the large east and west valley studied, it built masses of moraine in the valley and water rose in the tributary valley leading southward from Loudonville until it was pushed over the divide at Spellacy. When the ice withdrew, it became more markedly a series of valley dependencies, and the water accumulated in front of their noses until it went over the col in Muddy Fork northwest of Lakeville, but because of ice obstructions it could not go along the large valley leading to Big Prairie. Thus was started the stream over the divides between the narrow valleys and not along the earlier mature valleys.

Once started it was easier for the stream, when the ice withdrew, to maintain its course over the divides than to seek its old routes. Hence the cutting down continued and the little narrows were finally cut to present dimensions. The cutting down of the divide gave all side streams near the divide a chance to deepen their courses near their mouths which they proceeded

*Carney, F. (Jour. Geol. XV, 1907 pp 488 ff.) very happily applies this term to peripheral protuberances, which extended from the great ice sheet into preglacial rock valleys.

to do. Thus the theory seems to explain and incorporate every observed fact and not to be out of harmony with the general conditions of the vicinity.

Since drift of Wisconsin age lies in the smaller valleys and since the observed stream erosion, accomplished subsequent to the diversions, is so great, it is believed that the original diversion must have occurred in connection with some pre-Wisconsin ice invasion probably the earliest to come to this region.

DESCRIPTIONS OF NEW MALLOPHAGA. III.

E. P. DURRANT.

6. **Menopon colaptis,** nov. sp. Fig. 1, H.

Description of female. Body, length 1.82 mm., width .74 mm.; of pale golden-brown color, with darker and narrow transverse abdominal bands, many of the specimens, however, showing a reddish tinge.

Head, length .27 mm., width .58 mm.; forehead broadly rounded with temples projecting; on front of head near lateral margins, arising from a clear space, two small, and one large hair; palps projecting a little more than terminal segment; a distinct ocular fringe; back of eye two small hairs, and on temple two long ones; occipital border concave with eight long hairs and with narrow brown marginal band; head of rather uniform coloring, inner border of antennal pit dark; ventral surface with a pair of three-jointed backward-extending processes one-third the length of the head.

Prothorax large, with thin smoky lateral extensions reaching as far as first long hair on occipital border; two long pustulated hairs on each lateral margin and eight on the posterior, the one at the anterior angle with a small spine on each side of it. Metathorax a little broader than the prothorax, with the posterior border slightly curved backward and with a number of hairs; legs of the general body color.

Abdomen somewhat elongate, angles projecting slightly and bearing one long and two shorter hairs also one or two small spines; a row of hairs extending across near posterior margin of each segment; posterior border of last segment flattened and with a row of small hairs, a close fringe of fine hairs on ventral margin.

Male. Body, length 1.54 mm., width .78 mm.; head, length .27 mm., width .59 mm. Except in size much the same general appearance as the female.

Description from twelve specimens in the collection of Professor Jas. S. Hine, of Ohio State University, taken by him from the Flicker, Colaptes auratus, at Columbus, Ohio

These forms show much similarity to *Menopon praecursor* Kell and may possibly be only a variety. However, on account of the host, from which heretofore no Menopon has been reported, the difference in prothorax, the hairs of occipital region, and the more elongated body I have assigned it specific rank

7. **Menopon titan** PIAGET. (New host) Les Pediculines, 1880, p 503, plate XL, fig 7.

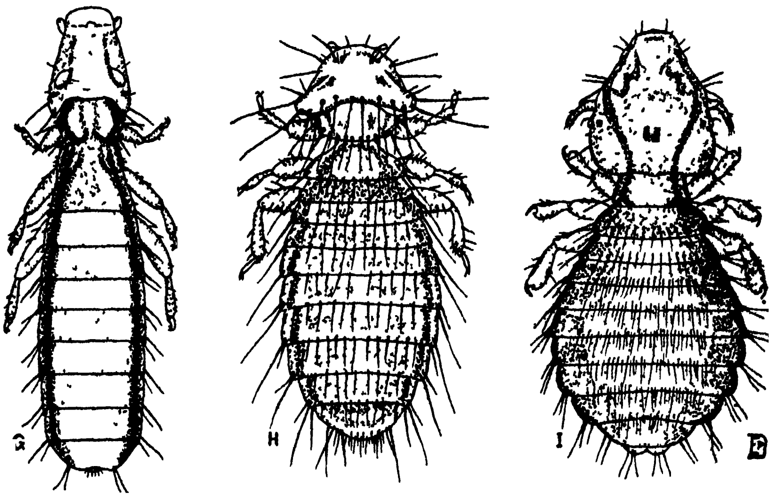

Fig 1. G, Physostomum invadens Kell, female from Dendroica pennsylvanica. H, Menopon colaptis, female from Colaptes auratus. I, Docophorus syrnii, female from Syrnium nebulosum.

Taken from Phalacrocorax dilophus by Professor Jas. S. Hine at Columbus, O. Professor Kellogg, KELLOGG and CHAPMAN, Mallophaga from Birds of California, New Mallophaga III, 1899, describes the variety *incompositum* from Phalacrocorax penicilliatus. The specimens from P. dilophus conform very closely with Piaget's description

8. **Eureum cimicoides** NITZSCH. (New host.) PIAGET, Les Pediculines, 1880, p. 608, Supplement, 1885, p. 137, Plate XV, fig. 2.

Two specimens taken from Chaetura pelagica by Professor Jas S. Hine, at Columbus, O. In KELLOGG and CHAPMAN, New Mallophaga III, p. 133 *et seq.*, reference is made to the seemingly inadequate ground for the establishment of the Genus *Eureum*, and also to the suspicion on the part of Piaget that the forms so

named were only aberrant members of the genus *Menopon*. Professor Kellogg in *Psyche*, XV, p. 11, gives a systematic summary of the Mallophaga of the World, but makes no mention of this genus. However, it seems to the writer that the two specimens under consideration hardly can be placed in the genus *Menopon*. They agree closely with Piaget's description and figure, and the occipital tubercles, as Burmeister says, "*cum processu pronoti chelam formante*," have not their counterpart among the *Menopon* species so far as I have observed.

9. **Nirmis selliger** NITZSCH. (New host.) PIAGET, Les Pediculines, 1880, p. 197, plate XVI, fig. 2.

Two males and two females taken from the Common Tern, Sterna hirundo, on Hen Island, Lake Erie, by Professor Jas. S. Hine.

10. **Physostomum invadens** KELL. Fig. 1 G. A single specimen taken from Dendroica pennsylvanica at Columbus, O., by Professors Osborn and Hine.

This single female specimen conforms quite closely to the description by Professor Kellogg in New Mallophaga III, KELLOGG and CHAPMAN, p. 50, the only apparent difference being that it is a little more slender as shown by the following dimensions: Body, length 3.06 mm., width .68 mm.; head, length .70 mm., width .53 mm.

11. **Docophorus syrnii** [PACKARD?], fig. 1 I.

Female. Body, length 2.08 mm., width .92 mm., margin of abdomen, legs, and head colored a golden brown.

Head. Length .67 mm., width .66 mm., front obtusely angular with a slight acuminate projection at middle, one medium, and one short hair at each lateral angle; two small hairs in front of clypeal suture and two larger ones in front of trabecula; trabecula not so prominently curved as in D. communis, reaching a little beyond first segment of antenna; eye prominent and with a short curved hair above; temples broadly rounded, the distance from eye to prothorax divided into three nearly equal spaces by two long hairs, these spaces again nearly bisected by three short bristles; occiput perceptibly curved backward; signature distinct but not strongly marked; head rather uniform light brown, except antennal and occipital bands are distinct.

Prothorax with straight sides slightly diverging; a hair at posterior angle. Metathorax of equal length with prothorax, several hairs in rounded posterior angle; posterior margin nearly straight, with a row of pustulated hairs. Legs pale brown with dark brown markings on anterior margins.

Abdomen broadly elliptical, anterior segments scarcely projecting, posterior ones a little more so; two or three hairs at each posterior angle; short lateral transverse blotches with inner ends rounded; last segment deeply emarginate.

Male. Body, length 1.70 mm., width .70 mm.; head, length .59 mm., width .57 mm. Considerably smaller than female, coloration much the same. Last segment of abdomen rounded and clear; genitalia showing quite prominently.

This form bears some resemblance to D. cursor Nitzsch, but differs in size and in various other characters.

Many specimens taken from Syrnium nebulosum at Columbus, O., by Professor Hine. European writers refer to a form under this name, but Professor Kellogg, Proc. U. S. Nat Mus. Vol. XXII, p. 48, says, "neither Osborn nor I have been able to find the original record for this species." Hence the figure and description given in this paper.

This work was done mostly in the Zoological Laboratory of Ohio State University under the directoin of Professor Herbert Osborn, whose kindly assistance is hereby gratefully acknowledged. Thanks are due also to Professor Jas. S. Hine for access to his collection of Mallophaga

THE DEPOSITS OF GLASS SAND AT TOBOSO, OHIO.[1]

F. Carney and A M. Brumback

This glass sand quarry, about one half mile west of Toboso, on the Baltimore & Ohio railroad, is conveniently reached by traction line from Newark to Zanesville, leaving the car at the Black Hand station. The quarry, located in a cliff bank on the south wall of the Licking which joins the Muskingum at Zanesville, is owned by the Edward H. Everett Company of Newark, Ohio. The sand produced is used chiefly by the American Bottle Company of the same place. This company manufactures annually about 1,000,000 gross of amber and green bottles.[2]

The rock used here for glass sand belongs to the Black Hand formation of the Waverly series, Mississippian period. A section at the quarry, measured and described by Professor Charles S. Prosser, is as follows :

1. Presented at the Annual Meeting of the Ohio Academy of Science, Oxford, Nov. 30. 1907.

2. Figures supplied by Mr. J. M. Keckley, employed by the American Bottle Company, Newark, O.

FIG 1 The coarsely rippled surface of Conglomerate II, which caps the stone used for glass sand above this, about twenty feet of the Logan shows

FIG 2 View of the east end of the Everett quarries, showing the cable and conveyor, camera stands on the north bank of the Licking which flows at the foot of the retaining wall of the railroad, the Baltimore and Ohio. The prepared sand is loaded directly into the cars

SECTION OF SOUTHERN BANK OF LICKING RIVER AT EVERETTS AND CO'S QUARRY[3].

	Thickness Feet	Total Thickness Feet
No. 6. Till....................................	7	101
5. Thin, irregular bedded, drab or bluish sandstone and bluish argillaceous shales. In places at the bottom is a 3-inch clay shale resting on the massive conglomerate with a sandstone to conglomerate layer above. Lower part of the *Logan sandstone*......	22	94
4. A coarse conglomerate stratum at the top of the conglomerate which in places is 11 inches thick. The top of the *Black Hand conglomerate*....	1	72
3. Gray to drab coarse grit, which in places is a conglomerate that is worked for glass sand. This forms the upper part of the main cliff........	21	71
2. Coarse grit and conglomerate to the base of the cliff at the Crusher.............	16	50
1. Mostly covered bank below the Crusher but all in the conglomerate as shown by exposure a little farther down the river Level of Licking River.	34	34

The very coarse horizon, Conglomerate II[4], No. 4 in the above section, and the erosion-remnants of the superjacent Logan sandstone (Fig. 1.) are stripped, and dumped into an abandoned water-course a few rods east of the quarry. The first mill for preparing the sand was built at the west end of the quarries; the new mill, which more than doubles the capacity of the plant, stands nearer the place where quarrying is now being done.

The stone is conveyed to the older mill by a cable (Fig. 2.) which lifts the skips from the trucks that have been pushed along temporary tracks to a point directly beneath the cable. Tracks lead to the new mill, and by raising the trucks a few feet, the stone is fed into the breaker directly from the skips. After leaving the breaker the stone passes through a Williams pulverizer, is screened, then fed into a Philip-McLearen wet pan where it passes between heavy "chasers," and is next washed by being augered through a trough against flowing water which floats off some of the aluminates. They do not dry the sand, but car it directly from the washer, or pile it for later shipment. The present daily output is about 300 tons.

3. Journal of Geology, Vol. IX (1901), p. 228.

4. C. L. Herrick, Bull. Denison University, Vol. IV (1888), p. 105.

C. S. Prosser, American Geologist, Vol. XXXIV (1904), pp. 358-60.

The analysis of two samples of this sand shows a much higher percentage of iron than is contained by the sands ordinarily used for glass:

	1.	2.
SiO_2	84.24	84.41
Fe_2O_3	2.88	2.91
Al_2O_3	7.00	7.15
CaO	.70	.69
MgO	.47	.38
Loss on ignition	2.29	2.29
Alkalies, etc., undetermined	2.42	2.17
	100.00	100.00

Among the undetermined elements, titanium has been detected, but no attempt has been made to ascertain its amount.[1]

1. See Ernest F. Burchard, "Glass Sand Industry of Indiana, Kentucky, and Ohio," Bulletin U. S. Geological Survey, No. 315, (1906), pp. 372–373, for an earlier description of this deposit. On page 376 he gives analyses of several sands.

Denison University, Granville, O.

ON THE DEATH OF WILLIAM ASHBROOK KELLERMAN.

(Resolutions adopted by the Biological Club, May 4, 1908.)

Inasmuch as Dr. William Ashbrook Kellerman died on the eighth of March, 1908, the Biological Club of the Ohio State University wishes to record its estimate of the worth of the man and its sense of loss in his sudden death.

Dr. Kellerman became allied with the club almost at its beginning and for many years was one of its most active and enthusiastic members. He served as president in 1891-1892. In starting the chief enterprise of the club, the Ohio Naturalist, he had a very large part. Indeed, when the establishment of such a periodical seemed beyond the financial means of the club, it was he who generously came forward and assumed the burden, proving his faith in the success of the venture by accepting extra numbers of the journal as security for his advances. Without this aid the present valuable journal of the club could scarcely have been undertaken.

Until handicapped by a difficulty in hearing which arose in the last few years, he was one of the most active participants in the discussions of the club, always adding interest and profit

to its meetings. Many of his papers, since published, were read for the first time in its sessions. In addition to these more formal contributions not less important though less pretentious were the many brief notes which he contributed under the head of personal observations. Never did a meeting pass at which he was present without his reporting some new and interesting discoveries he had made during the month. These short observations reveal a trait in his character which is becoming all too rare in the younger biologists, namely, his love of nature and his passion for study and collection in the field. In all of his forty years of collecting and close study of nature, he never lost in the slightest degree the enthusiasm of the youth making his first discoveries in science. From first to last he maintained unabated his great interest in the commonest things. At all times he enjoyed with the greatest intensity every observation made by his students, even if it was well known to him. Because of this he was one of the most stimulating persons any young man could have had to work under. Those who knew him in the field can never forget the keen enjoyment of field trips with him nor the profit derived from them.

As members of the Biological Club, many of us only beginning our scientific careers, we would recognize the inestimable value of such an impelling interest in our work and set it up as a mark for our own ideals, knowing full well that though few of us can hope to attain such intensity of enthusiasm as he reached, yet our success in large measure depends on our ability to maintain as Dr. Kellerman did, the enthusiasm of youth through the years of mature life.

ROBERT F. GRIGGS,
F. L LANDACRE,
J. C. HAMBLETON
Committee

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NOTES ON DINICHTHYS TERRELLI NEWBERRY, WITH A RESTORATION.

CONTRIBUTION FROM THE GEOLOGICAL LABORATORY OF OBERLIN COLLEGE.

E. B. BRANSON.

In volume seven of the Ohio Geological Survey, page 626, Professor A. A. Wright gives measurements of the bones of an almost complete specimen of *Dinichthys terrelli* Newberry. This is probably the most complete specimen of *Dinichthys* ever collected. The only bones missing are right mandible, right antero-supero-gnathal, left postero-supero-gnathal, left postero-dorso-lateral, and the median ventrals. The skull is crushed in such a way that the right suborbital lies at the right in the same plane as the roof of the skull. The left sub-orbital and left margin of the skull lie against the bottom of the roof. The dorso-median is broken and the shaft turned to the left.

Many of the bones are not perfectly preserved. The lower part of the right clavicular is missing, neither antero-dorso-lateral is perfect, the left clavicular has several parts broken away, the left suborbital is imperfect posteriorly and the right suborbital is imperfect anteriorly, and other bones have small portions missing.

The accompanying restoration is made from this specimen and the excellence of the specimen leaves few points in doubt. Nearly all of the points were checked up with other specimens.

The ventrals are those figured by Professor A. A. Wright in volume seven of the Ohio Geological Survey.* The specimen furnishes no positive indication of the relation of the ventrals to the other bones, but the left antero-ventral is crushed against the right antero-dorso-lateral. The position of the ventrals shown in figure 1 represents nothing more than the writer's opinion of their proper location.

* Ohio Geological Survey, Vol. VII, Plate XLIV, figs. 1, 2, 3, 4, and 9.

In figure 1 all bones of the side of the skull are foreshortened since in a direct lateral view they lie at an angle of about thirty-five degrees with the median line of the skull. The suborbital, mandible, dorso-laterals, and clavicular are foreshortened dorso-ventrally. They lie at an angle of about forty-five degrees with the median longitudinal vertical plane of the body. This angle was obtained from an undistorted dorso-median of the same species. The relations of the other bones to the dorso-median make it certain that it is approximately correct. In figure 2 the bones are represented as lying in one plane almost exactly as they lie in the specimen and all bones are drawn in proportion.

The sutures in the skull are not distinct. The median occipital and external occipital are the only bones of which it is possible to make out the outline distinctly.

The suborbital as shown in figure 2 lies just as it does in the specimen. The anterior end is restored from the anterior end of the left suborbital. The notched anterior end has not been figured or described previously that I am aware. In the interior of the notch the bone is fifteen millimeters thick and apparently articulated with some other bone. The anterior slime canal seems to be continuous with the anterior slime canal of the top of the skull. The bone is usually broken where the slime canal crosses it and the anterior end lost. Behind the orbit the suborbital articulates with the postorbital for a short distance and then does not touch the margin of the skull again till about the middle of the marginal. At the place where it articulates the slime canal of the marginal reaches the edge of the skull. Behind the postorbital a bone lies between the suborbital and the roof of the skull. It overlaps the upper edge of the suborbital and is crushed against the skull in such a way that its relations can not be determined. It is probably part of the left suborbital displaced when the skull was crushed. The posterior end of the suborbital lies against the inner part of the anterior projection of the clavicular and thus completes the boxing in of the posterior part of the skull as well as making the clavicular more rigid. The top of the bone is thin and sinuous in outline. The dotted lines in figure 2 indicate the parts of the bone that are missing.

DINICHTHYS TERRELLI NEWBERRY.

Figures 1 and 2. One-fifth natural size.

1.	Median occipital,	10.	Clavicular.
2.	External occipital.	11.	Dorso-median.
3.	Central.	12.	Antero-dorso-lateral.
4.	Marginal.	13.	Postero-dorso-lateral.
5.	Pineal.	14.	Mandible.
6.	Postorbital	15.	Postero-supero-gnathal
7.	Preorbital.	16.	Antero-supero-gnathal.
8.	Rostral.	17.	Anterior ventral.
9.	Suborbital.	18.	Posterior ventral.

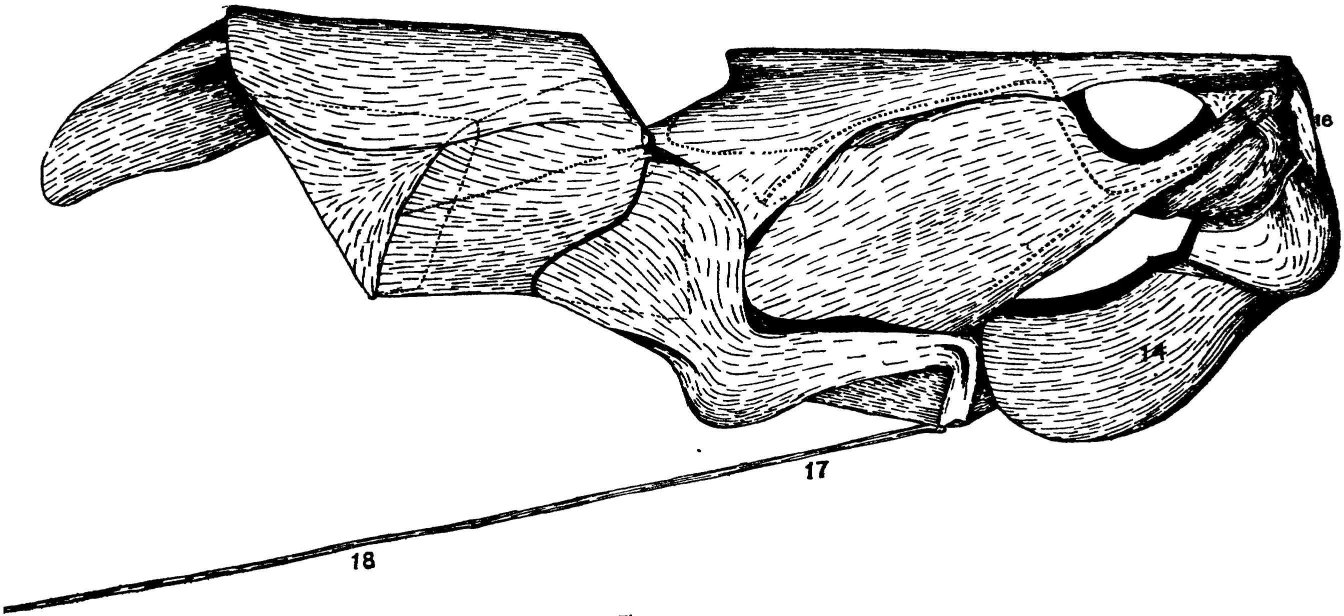

FIGURE I.

The relations of the dorsal to the dorso-laterals is shown in both restorations. In the specimen the postero-dorso-lateral and antero-dorso-lateral are firmly united in their original relation. Some fragments are missing from the upper margin and are restored in outline in the drawings. The right margin of the dorso-median is missing in the specimen but its position and shape are almost perfectly indicated on the dorso-laterals. Outside of the dotted line in figure 2 the antero-dorso-lateral is restored. As the left postero-dorso-lateral is crushed down on the right dorso-laterals their relation to one another is obscured. The writer is not satisfied with the outline of the antero-dorso-lateral as it is shown in the drawing, but the bones are undoubtedly in their natural association and the antero-dorso-lateral is the only bone to fill the space in front of the posterior bone. The overlapping part of the antero-dorso-lateral is very thin.

The relation of the antero-dorso-lateral to the skull is determined beyond controversy by the specimen under discussion and by two other specimens in the Museum of Oberlin College. The relation is determined by placing the dorso-median and dorso-laterals in association and placing the median line of the dorso-median in the median line of the skull and the articulating part of the antero-dorso-lateral in its socket. The anterior edge outside of the articulation overlaps the depressed edge of the posterior part of the skull for about two centimeters. A specimen of *Dinichthys intermedius* shows the same relation, and in a specimen of *Dinichthys* recently collected from the Huron shale in which both antero-dorso-laterals are preserved in their natural relation to the skull the same relation is shown.

The position of the clavicular and its relations to other bones is definitely shown and is represented in both restorations. The main articulation is with the depression in the antero-dorso-lateral. Its anterior edge overlaps for more than two centimeters the depressed posterior edge of the skull though it does not articulate with the skull. The posterior end of the suborbital rests against a large part of the anterior edge of the clavicular between its two anterior projections. The outer of the anterior projections which just reaches the lower edge of the suborbital probably supported a lateral appendage. It diverges from the inner projection at an angle of about forty degrees but soon curves inward and runs nearly parallel with the inner part. The distal end of this projection is a separate bone. It is sometimes ankylosed with the rest of the bone but is detached in many cases. It should be classed as a distinct skeletal element. If it is homologous with any bone of other vertebrates the writer is in doubt about the homology. The inner anterior projection of the clavicular extends further forward than the outer, and the anterior end supports the mandible. In the restorations the inner part is dis-

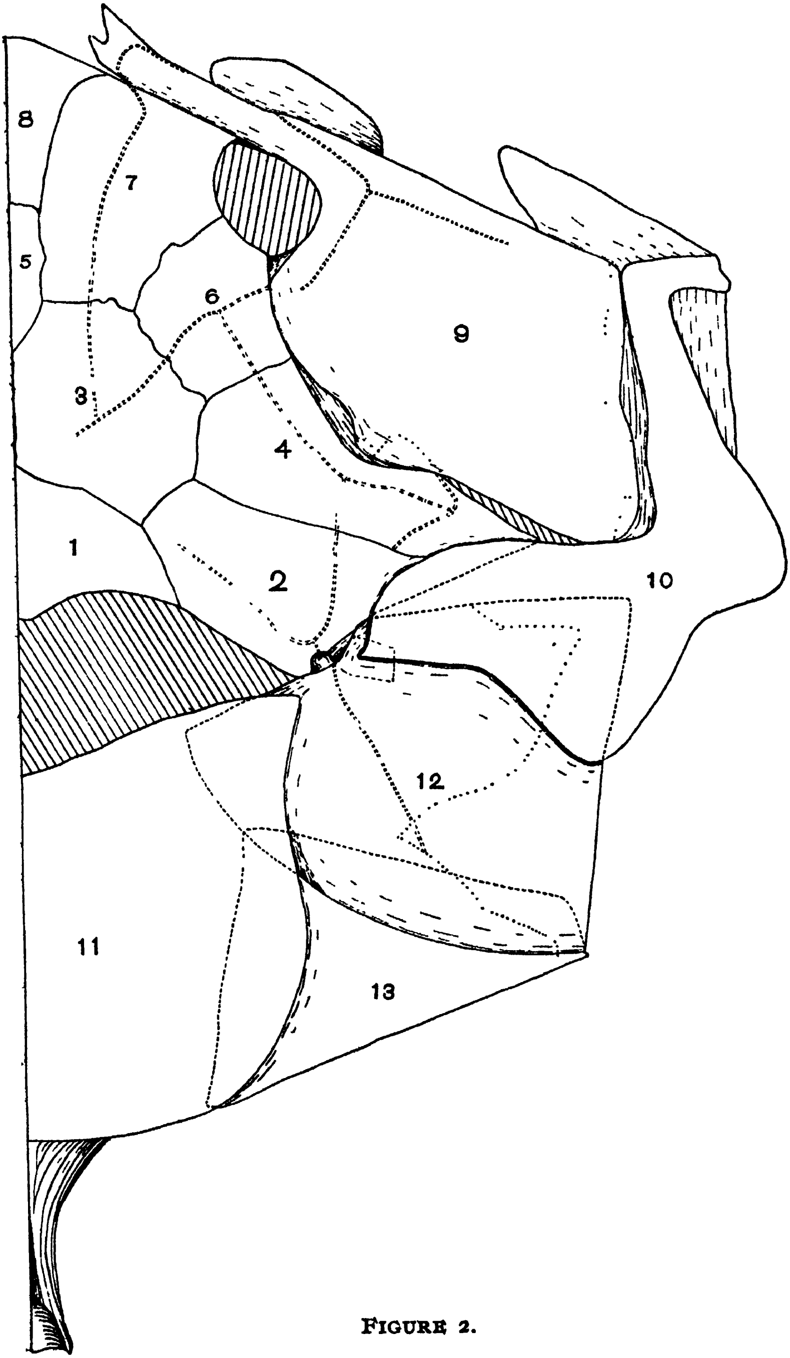

FIGURE 2.

tinguished from the outer by heavier shading. The part that projects forward beneath the suborbital is missing in all specimens at the writer's disposal and is restored in the drawings after Newberry[1] and Hussakof.[2] A part of the upper end is restored in their specimen but is present in this one. In the specimen under consideration there is no indication of a thickened edge of the mandibular support.

The arrangement of the supero-gnathals as near as can be ascertained is the same as in *Dinichthys curtus* as figured by Hussakof.[3] Their exact relation to the suborbital is not clear, though it is essentially that shown in figure 1. The anterior end of the suborbital is complete on the left side but the postero-supero-gnathal is missing. The anterior end of the suborbital is missing from the right side. The notch in the anterior end of the suborbital apparently fitted against some part of the antero-supero-gnathal, but it is impossible to determine this fit with the specimens at the writer's disposal.

Placing the mandible in its natural relation to the supero-gnathals it is found that the posterior end rests just beneath the postero-infero-corner of the suborbital and against the inner anterior projection of the clavicular. The conclusion that the mandible rested against this projection is necessary. There is no other bone which could furnish support for it. Hussakof indicates this attachment in a general way in figure 1 of the paper above cited.

The slime canal on the marginal does not extend to the angle of the marginal but branches to right and left as shown in figure 2. In other respects the canals do not differ materially from the way they are represented by Hussakof in figure 24C of the paper just cited. The shape of the skull differs considerably from Hussakof's restoration but agrees with Newberry's figures in Plate IV, Monograph XVI, of the United States Geological Survey.

The dimensions of the bones following Hussakof's method of measuring, are as follows:

1. Monograph XVI, U. S. Geol. Surv., Plate XLVIII, figs. 1 and 2.
2. Mem. Am. Mus. Nat. Hist., Vol. IX, Pt. III, p. 133, fig. 19.
3. Mem. Am. Mus. Nat. Hist., Vol. IX, Pt. III, p. 112, fig. 5.

NAME OF PLATE.	LENGTH	WIDTH	REMARKS.
Skull	37 cm.	29 cm.	Width between anterior extremities of orbits.
		65 cm.	Greatest width.
Dorso-median	45 cm.	....	
	31.5 cm.	....	Length without shaft.
		44 cm	
Antero-dorso-lateral	24 cm	24 cm.	About.
Postero-dorso-lateral	11 cm.	....	Not including overlap.
		26 cm.	About.
Clavicular	30 cm.	....	Dorso-ventrally.
	20 cm.	....	Part from which lateral appendage is suspended, measuring from the place where the two branches diverge.
	33 cm.	....	Part to which the mandible is attached.
		18 cm.	Greatest width where it overlaps antero-dorso-lateral.
Suborbital	35 cm.	....	From anterior to posterior end along lower margin.
	42 cm.	....	From anterior end to opposite posterior end of upper margin, along lower margin.
	28 cm.	....	Greatest length behind orbit
		17 cm.	Greatest width behind orbit.
Antero-supero-gnathal	11 7 cm		
	8.2 cm.	....	Length of supporting shaft.
		9.5 cm.	Width of cutting part, including prong.
Postero-supero-gnathal	14 cm.	10.2 cm.	Measured on outside and including shaft.
		8.8 cm.	Measured on inside and including shaft.
Mandible	39.7 cm.	12 cm.	
Anterior ventrals	41 cm.	12 cm.	
		18 cm.	At the anterior end.
Posterior ventrals	42 cm.	18 cm.	

ON THE AQUATIC AND SEMI-AQUATIC HEMIPTERA COLLECTED BY PROF. JAMES S. HINE IN GUATEMALA.

(First Paper.)

J. R. DE LA TORRE BUENO.

When Professor James S. Hine made his trip to Guatemala in the winter of 1905, he was good enough to permit me to secure his collections of Aquatic and Semi-Aquatic Hemiptera, and I gladly availed myself of the opportunity. As a consequence, I received one of the most notable single collections of waterbugs that has been made. This collection has been in my hands for study for the last three years, but owing to the breaking-down of my health and to other reasons no less imperative, my work on it has been so slow that it has seemed to me convenient to publish what results are in shape at present, and the remainder as shortly after as may be done.

When Mr. G. C. Champion made his protracted stay in Central America in 1879–83, his efforts yielded 72 species in 32 genera, for the whole region treated of in Biologia Centrali Americana, of which 53 species in 24 genera were captured in Guatemala. The total number of species *recorded* from that region and noted in the work cited numbered 136 in 32 genera, two being new, of which records 53 species, 23 of them new, in 25 genera, were found in Guatemala.

Prof. Hine's collecting was far more successful, both as to number of specimens and new and unrecorded forms, and undescribed genera. All the families of waterbugs are well represented, although no examples of eight genera were secured, these being *Merragata* (*Hebridae*), *Velia* and *Platygerris* (*Gerridae*), *Mononyx* (*Nerthridae*), *Curicta* (*Nepidae*), *Cryphocricos* (*Naucoridae*), *Plea* and *Notonecta* (*Notonectidae*), and *Corixa* (*Corixidae*). On the other hand, Prof. Hine adds to the fauna three heretofore unrecorded genera and two new ones, as well as a large number of undescribed species, exceeding 18. The three genera new to the fauna are *Rheumatobates* and *Trepobates* (*Geridae*) and *Martarega* (*Notonectidae*). Appropriate comment will be made on all these in the proper place.

It is my intention to present three papers on this material, this being the first, the other two to follow as quickly as may be. The paper here given is the work of Dr. E. Bergroth to whom I submitted an unrecognized *Rheumatobates* and another obscure *Gerrid*, which he kindly describes in the following pages. The other two papers will be devoted to the *Trochalopodous* and *Pagiopodous* forms respectively.

To make any comment on Dr. Bergroth's finished work "were to paint the lily," nevertheless a few remarks for greater clearness may not be out of place. The paper in question, while based on some of the Guatemalan material does not cover all the specimens, nor give all the records, since only a few of the *Trepobates* were sent, with others from Arizona. The other localities will appear in the systematic part of the list.

In reference to *Rheumatobates*, the brush at the inner end of the fore tibia is also to be found in other Gerridae and its use appears to be for cleaning the antennae at least, an operation repeatedly observed by me in *Microvelia americana* Uhler. While their apparently preferred habitat is in running waters, in my experience *Rh. rileyi* appears to prefer coves and slack waters along the banks of the streams it frequents. Nevertheless, I have found it abundant in a lake in New Jersey, in places where there was *no current*, so it would appear to me that it is not altogether impossible to breed them. Dr. Bergroth also very fully described the winged form of *Rh. tenuipes* Meinert, of which and also of *rileyi*, I possess specimens. But I have also taken a *brachypterous* form in this latitude, in which the hemelytra do not reach the end of the abdomen, being apparently truncate. In some subsequent paper, I hope to be able to more fully elucidate these points.

FAMILY GERRIDAE. SUBFAMILY HALOBATINAE.

E. Bergroth.

To this subfamily I refer only the genera having the inner margin of the eyes convexly rounded. In the subfamily Gerrinae the ocular orbita is arcuately sinuate behind the middle. Mayr (Reise d. Novara, Hem., p. 169) was the first who based the primary subdivision of the Gerridae on this character. But little attention has been paid to it by Bianchi and Champion, and none at all by Distant in his Fauna of British India, but it is carefully indicated in Kirkaldy's generic descriptions. As character for the two subfamilies Bianchi solely gave (in which he was followed by Distant) the breadth of the body compared to its length, a feature entirely unsatisfactory as justly observed by Champion who does not accept the subfamilies. Of the genera included in the Halobatinae by Bianchi at least one—*Potamometra* Bianchi—really belongs to the Gerrinae. I may be mistaken, but I believe that the character derived from the form of the eyes, slight as it may seem, is indicative of a real affinity between the genera having these organs similarly built and I also believe that this rather trivial character could be supported by others when these polymorphous, as yet little known and little understood insects have undergone a thorough and much needed

revision in the hands of a competent hemipterist disposing of ample materials. But from our present scanty knowledge of them to this desideratum is a long step.

Trepobates pictus H. Sch.

Several specimens of the apterous form from Amatitlan, Agua Caliente and Mazatenango, and two macropterous specimens from Gualan.

This is a very variable insect. Most of the Guatemalan apterous specimens have the mesonotum black with two longitudinal curved yellow bands turning their convexity outwards. Specimens from Phoenix, Arizona, and Sligo Glen, Maryland, are similarly colored. In a few of the Guatemalan specimens the mesonotum is entirely black or nearly so, and of this variety I have a specimen from Florida. In specimens from Glen Echo, Maryland, there are four curved bands forming on either side of the mesonotum a rather irregular yellow O which sometimes is incomplete with the ends open, and there is also an oblique yellow streak near the apical angles. I am unable to find any reliable plastic differences between these varieties.

The hemelytra of the winged form have been described by Uhler in Proc. Zool. Soc. London, 1894, p. 213–214. In this form the posterior triangular process of the pronotum is margined with yellow and the whole antehumeral part of the pronotum has an intralateral yellow vitta which usually joins the yellow margin of the process but which in some specimens is abbreviated posteriorly; sometimes there is also an oblong median yellow spot near the apical pronotal margin. The sooty black wings are shorter than the hemelytra but considerably longer than the abdomen and are not folded under the hemelytra. The apical margin of the corium is well marked, except at the inner angle, and placed at right angles to the costal margin and to the longitudinal axis of the body when the hemelytra are closed. The inner vein of the corium is shortly furcate at the apex. The pale longitudinal vitta of the membrane, mentioned by Uhler, is very obscurely indicated in most specimens. The median vein of the membrane is fold-like and usually reaches the apex of the loop formed by the elevated outer and inner vein.

Trepobates pictus exactly agrees with the short generic description[1] of *Callistometra* Kirk. According to Kirkaldy this genus differs from *Trepobates* Uhl., "in the incrassation of the anterior femora, in the straightness of the posterior margin of the mesonotum, etc." The incrassation of the anterior femora is,

1. In the statement, "suture between meso- and meta-sternum straight," metanotum is apparently to be read instead of metasternum; this confusion of the sterna and the nota is frequently met with in the descriptions of this author.

however, in some Gerrid genera only of specific importance and the posterior margin of the mesonotum is perfectly straight also in *Trepobates*. Kirkaldy further adds: "The length of the abdomen, moreover, will distinguish it from any of the smaller Halobatitae." Unfortunately the author in his description gives no statement whatever as to the length of the abdomen. But as the genus *Rheumatometra* Kirk. (of which I have cotypes) differs from the allied genera by a multitude of characters not mentioned in the description, I think that this also may be the case with *Callistometra*. In point of fact Kirkaldy states in the specific description of *C. Taylori* that the last ventral segment of the female is "roundly emarginate." This would indicate a genus more nearly allied to *Metrobates* Uhl. and *Telmatometra* Bergr. than to *Trepobates* in which the apex of the last female ventral segment is truncate. The posterior femora of *C. Taylori* are said to be "about seven and one-half times longer than the tibiae." If this statement is correct the posterior tibiae are exceedingly short.

The genus *Halobatopsis* was founded by Bianchi on the description of the fresh water Gerrid *Halobates platensis* Berg and is said to have the "first joint of the antennae about one-fourth shorter than the second and third combined" whilst *Trepobates* is stated to have the "first joint of the antennae not shorter than the second and third combined." This would be a very slight difference, unsupported as it is by other characters, and the antennae of *Trepobates* are really variable to a certain extent, some specimens agreeing with the diagnosis of *Halobatopsis*. According to Bianchi *Trepobates* has the "second joint of the antennae about two-thirds of the third" and the "fourth joint of the antennae distinctly longer than the third. "The mutual length of the last three antennal joints of *Trepobates* is, however, also somewhat variable and on the whole they can be said to be of subequal length. The hemelytra of *Halobates platensis* are thus described by Berg.: "Hemelytra basi biareolata, deinde venis tribus longitudinalibus (vena media pliciformi) instructa." This exactly fits *Trepobates* and there is nothing in Berg's description indicating that *Halobates platensis* is generically distinct from *Trepobates pictus*. Ashmead has described a Canadian species under the name *Halobatopsis Begini*. I am at a loss to make out why he has placed it in the genus *Halobatopsis* Bianchi as the first antennal joint, in direct opposition to the only generic character given by Bianchi, is described as "distinctly longer than joints 2 and 3 combined." The second joint, too, is said to be "longer than the third, the latter being about three-fourths the length of the second," whereas *platensis*, the type of the pretended genus, is described by Berg as having "articulo secundo

tertio breviore." Judging from the description *Halobatopsis Begini* Ashm. belongs to a new genus.

Trepobates pictus is not recorded from Central America in the "Biologia" but it was recorded from Tamaulipas, Mexico, by Uhler in 1884, and is distributed southwards at least to Venezuela from where I have winged specimens.

Telmatometra Bergr., n. gen.

Body about two and one-half times longer than broad. Head subtriangular, much broader than long, rounded in front, anteocular part much shorter than the eye; seen in profile the apex of the head is subangularly rounded and distinctly projecting beyond the base of the rostrum; eyes prolonged backward beyond the basal margin of the head by nearly one-fourth their length, the prolonged part touching the lateral margins of the prothorax, the upper inner margin of the eyes rounded; the parallel-sided, at the base somewhat dilated clypeus not visible from above, bent back towards the underside of the head, giving the head a somewhat "homopterous" appearance when seen in profile; labrum almost reaching the apex of the first rostral joint; rostrum extending considerably beyond the anterior margin of the mesosternum but not reaching its middle; second joint very short, ring-like, third joint long; antennae inserted immediately before the eyes a little above the level of their lower margin, long and thin, in the female distinctly passing the base of the venter, in the male (owing to the shorter abdomen) almost reaching the tip of the abdomen, third joint longest, even longer than the basal joint and more than twice as long as the second joint, fourth joint almost twice the length of the second, the two basal joints a little thicker than the two thread-like apical joints. Thorax widening from the apex to the middle acetabula, sides very slightly rounded, more distinctly so towards the apex. Pronotum in the winged form extending backwards over the mesonotum, widening from the apex to the humeral angles, then gradually tapering to the rather narrowly rounded end, the apical margin straight between the eyes. Mesosternum convex without rostral furrow, broadly arcuately sinuate posteriorly. Mesopleurae bent over to the dorsal side of the thorax, a narrow posteriorly broadening part of them being visible from above. Metasternum very short, of the same size and appearance as the first ventral segment, orificium not visible, apparently hidden under the posterior margin of the mesosternum. Metapleurae visible only from above, separated from the dorsal part of the mesopleurae by a deep oblique suture. Hemelytra complete in the winged form, membrane well separated from corium except at the inner part where it is subconfluent with the endocorium and the claval area; corium with the subcostal vein usually obliterated towards the

end, median vein forked a little before the apex, the outer branch merged in the apical margin of the corium, the inner branch running some distance into the membrane where it joins the inner (claval) vein, forming a loop emitting a vein from its apex; apical margin of corium extending from the median vein to the costal margin; apical angle of corium acute. Wings folded under the hemelytra in such a way that they scarcely reach the middle of the abdomen. Abdomen about as broad as the pronotum between the humeri, the dorsal side in the male a little shorter, in the female a little longer than the pronotum, venter in the male shorter, in the female longer than half the length of the mesosternum; the last segment of the connexivum tapering from the base to the pointed tip, in the female projecting backwards and reaching the middle of the first dorsal genital segment to the margin of which it is closely attached; the first five ventral segments short, of equal length, the sixth ventral segment in the female as long as the three preceding segments together, in the male a little shorter, arcuately sinuate behind, more profoundly so in the female; genital segments symmetrical, two such segments being visible in either sex from above and from beneath; first dorsal genital segment very much shorter in the male than in the female; first ventral genital segment entire in the male, in the female made up of two lobes contiguous along their whole length; apical genital segment in the male cleft in the middle when seen from the side, knob-like in the female. Legs slender, middle pair much the longest and inserted immediately under and a little in front of the hind pair, their trochanters passing the apical margin of the hind acetabula by half their length. Fore femora reaching the last fourth of the mesosternum, scarcely incrassated, slightly curved at the base; tibiae considerably shorter than the femora; tarsi shorter than half the length of the tibiae, first joint a little variable in length, second joint three or four times longer than first. Middle femora longer than the mesosternum, a little thicker than the fore femora, tapering from the base to the middle; tibiae longer than the femora; tarsi a little longer than half the length of the tibiae, two-jointed, first joint longer than second. Hind femora longer and conspicuously thinner than the middle femora; tibiae a little longer than half the length of the femora and more than twice shorter than the middle tibiae; tarsi about thrice shorter than the tibiae, two-jointed, joints of equal length.

Apterous form unknown.

Allied to *Trepobates* but at once distinguished by the structure of the head, antennae, corium and genital segments. The hemelytra seem to be exceedingly brittle in this insect. They are no doubt much longer than the abdomen but in all the six specimens before me the membrane is broken off near its basal margin making it impossible to give a complete description of its veins.

Telmatometra Whitei Bergr., n. sp.

Elliptical, ground color yellow. Head with a round apical spot and two rather irregular longitudinal fasciae above black, these fasciae touch the anterior angle of the eyes, are widening behind and do not reach the base of the head; antennae and last rostral joint blackish. Pronotum margined with black, except at the apex of the posterior process, and with two short apical vittae and a large oblong discal patch black, this patch being broadly rounded anteriorly, tapering and pointed posteriorly. Mesosternum with a longitudinal lateral line (interrupted a little behind the middle), an angular vitta in front of the middle coxae and a long slightly curved pleural vitta black. Suture between meso- and meta-pleurae and a vitta on the outer side of the hind acetabula black. Basal and apical margin of the dorsal abdominal segments, lateral margin of connexivum and the sutures between its segments black. Legs black, the femora usually with two pale testaceous streaks along their whole length and the middle femora with a pale subapical ring. First dorsal genital segment in the male shorter than the last dorsal abdominal segment, angularly emarginate at apex, in the female longer than said segment, arcuately sinuate at apex; first ventral genital segment in the male shorter than the last ventral segment, roundedly sinuate at apex, in the female as long as the last ventral segment, truncate at apex. Second female genital segment black. Length, ♂ 5 mm., ♀ 5.3–5.6 mm.

1 ♂ and 5 ♀ from Escuintla.

Named in memory of the late Dr. F. Buchanan White.

Rheumatobates praeposterus Bergr., n. sp.

Above plumbeous black, head, pronotum, sides of mesonotum (broadly) and connexivum velvety black, pronotum with a median quadrate or usually transversely rectangular whitish spot occupying the whole length of the pronotum, middle acetabula with a small round whitish or yellow spot at their base, basal part of the female dorsal genital segment often with a small yellowish spot; underside brownish black, mesosternum with a median crescent-shaped or triangular yellow spot and a large lateral whitish patch, fore acetabula, prosternum between them, the underside of the middle acetabula and the last female ventral segment whitish, the basal part of the female ventral genital segment tinged with whitish on the sides; antennae black, third joint in the male broadly whitish at apex, basal joint in the female, except at apex, fusco-luteous above, whitish beneath; rostrum brownish black, shining; legs black, fore and hind coxae, all trochanters and fore femora from the base to near the apex whitish, middle coxae fuscous or ob-

scurely luteous. Head with a few outstanding hairs on the lateral margins; eyes seen from the side reaching the mesopleura with one or two curved outstanding hairs near their posterior angle; second antennal joint very short. Pronotum more than three times broader than long, not reaching the lateral margins of the body, being separated from them by a short prominence of the mesopleura touching the backwardly prolonged eyes. Mesonotum almost one-half broader than long. Fore-legs: femora a little longer than the tibiae and tarsi together,

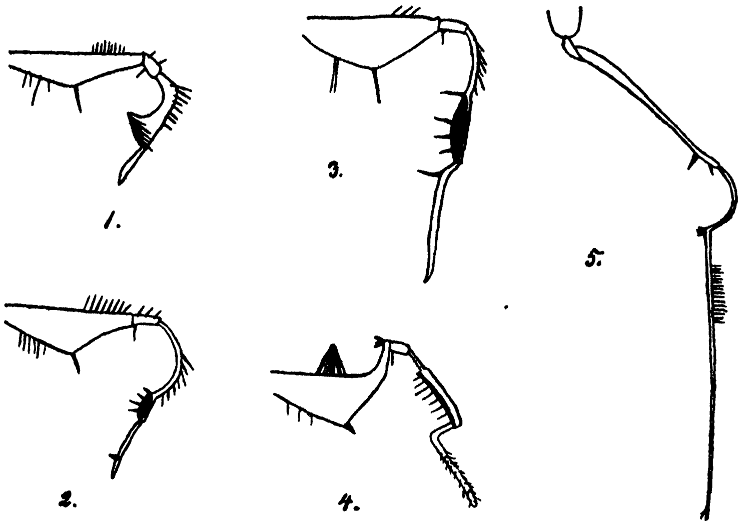

FIG. 1. Male antenna of *Rheumatobates imitator* Uhl.
FIG. 2. Male antenna of *Rheumatobates Rileyi* Bergr.
FIG 3. Male antenna of *Rheumatobates tenuipes* Mein.
FIG. 4. Male antenna of *Rheumatobates praeposterus* Bergr.
FIG 5. Right male middle leg of *Rh. praeposterus.*

In the Figures 2, 3 and 4. the antenna is figured from the outside and a little from behind in order to show the spongy pit of the third joint. Figure 1 shows the antenna from the inside, the spongy pit in this species not being visible from the outer side.

as long as the distance between the eyes and the middle coxae, fringed beneath with moderately long hairs; tibiae with two long hairs on the underside; tarsi distinctly shorter than the tibiae, claws very fine, hair-like. Middle legs: coxae considerably thicker than the hind coxae, especially in the male; trochantera convex, thicker than the linear hind trochantera; femora with a series of exceedingly short and fine colorless bristles on the underside; mutual length of tarsal joints a little variable, first joint three to four times longer than second. Hind legs: femora with

similar bristles on the underside as the middle femora, about one third longer than tibiae, these about two and a half times as long again as the tarsi; first tarsal joint usually a little longer than second. Length, ♂ 2–2, 2 mm., ♀ 2, 6–2, 9 mm.

Male: head, pronotum and mesonotum together longer than the rest of the body; first antennal joint as long as head, incrassated and compressed and with a submedian spine on the upper and under side, the apical part upturned with a tuft of hairs on the inner side of the tip, the upper margin of the joint almost straight from the base to beyond the middle, the lower margin angularly dilated, second joint inserted at right angles to the fore side of the apex of the first joint, third joint shorter than first with the short basal part narrower than the second joint, straight and linear, then moderately and suddenly incrassated but not dilated and proceeding in a gentle curve to the apex, the curved apical part occupying more than two-thirds of the joint and provided on the posterior side with a very shallowly impressed spongy surface with some stiff hairs on the lower margin and a tooth-like projection at the base, fourth joint a little longer than third, inserted at right angles to the backside of the apex of the third joint, unarmed, shortly pilose, rectangularly curved not far from the base (fig. 4); fore femora very slightly thickened towards the base; middle femora as long as hind femora, slightly curved and incrassated towards the base and with a spine on the inner side not far from the apex and a very short acute spur on the same side immediately before the apex, middle tibiae subsemicircularly curved at the base, turning the convexity of the curve outward, with a tuft of short hairs on the inner side of the tip of the curve, from which point to the apex the tibiae are straight with some rather short straight hairs on the outer side of the middle part (fig. 5); hind legs straight, simple, three fourths longer than the body, the tip of the abdomen slightly passing the base of the hind femora when they are stretched straightly backwards.

Female: head, pronotum and mesonotum together shorter than the rest of the body; antennae simple, linear, first joint a little shorter than the head, third joint a little longer than first with a few rather long and stiff hairs on the inner side near the base and apex, fourth joint as long as third; fore femora linear; middle legs straight, simple, femora longer than hind femora, tibiae a little shorter than femora and longer than tarsi; hind legs as long as the body, the tip of the abdomen reaching the apical fourth of the hind femora when they are stretched straightly backwards.

Four males, numerous females and some larvae from Puerto Barrios. No winged specimens were taken. The genus *Rheumatobates* was not previously known from Central America.

The median yellow spot of the mesosternum is sometimes almost lacking and in one specimen the whole body, including antennae and legs, is almost entirely sooty black with scarcely any traces of lighter markings.

To the upper spine of the first antennal joint in the male are attached a few hairs uniting its apical half with the surface of the joint. These hairs are never free, always glued on to or coalescing with the spine.

In the larva the mesonotum has a median yellow spot touching the anterior margin, as in the imagines of the other species, but this spot entirely disappears in the imago.

In two of the three previously described species of this genus the hind legs of the male are incrassated, curved and deformed in a curious way with singular chitinous processes, making them unique in their monstrousness among all known Heteroptera. In the male of *Rh. praeposterus* the hind legs are normal, it being the *middle* pair of legs which is misshapen and this only in a moderate degree.

The male antennae afford good specific characters for the different species of this genus and their structure is very remarkable and unprecedented among other Heteroptera. They much remind of the male antennae in the Collembolan genus *Sminthurides* and it would be interesting to know if they are used in the same manner as in *Sminthurides*, the male of which winds them round the antennae of the female during the copulation. They seem at least admirably adapted to this purpose. Or else could they be of use in clinging to stones, etc., when the insects are drifting down on swiftly running water. This is, however, less probable as the females have simple antennae. An other point of interest is that some of the spines and chitinous processes of the male antennae and legs seem to be composed of hairs cemented together by some viscous fluid. These insects probably have some glands secreting such a fluid. Under the microscope the last antennal joint shows several sense-organs and at the very tip an excavation bearing a short brush. A brush is also situated at the inner end of the fore tibiae. The spongy pit at the apical part of the third antennal joint may also be a sense-organ or possibly a suctorial organ. Unfortunately little is known of the biology of these insects although two species are common at certain points near the Atlantic coast, for instance at Glen Echo, Maryland. As they thrive only on running water it would be difficult if not impossible to rear and study them in aquaria. No species of the genus has hitherto been found far from the seashore and none is known from the Pacific Coast. Entomologists in Southern California should keep a lookout for them.

Riley made a strange mistake in regarding *Rh. Rileyi* Bergr. and *Rh. tenuipes* Mein. as the "abnormal" and "normal" form of one and the same species and thus they are generally designated in American collections. There cannot be the faintest doubt

that they are quite different species, as pointed out by Meinert in his magnificently illustrated paper on this genus. Riley was evidently led astray by the fact that the females of the two species are very much alike and that they often live together. Even the females are, however, readily distinguished by a glance at the underside. In *Rh. Rileyi* the mesosternum is yellow, unicolorous; in *Rh. tenuipes* it is yellow with the anterior margin and two backwardly diverging bands brownish black. By comparing numerous specimens I have found that this color-difference, although not mentioned by Meinert, is perfectly constant. Moreover, the breadth of the mesonotum as compared with its length is different in the two species. Riley also overlooked the different structure of the male antennae.

I quite agree with Heidemann that the genus *Hymenobates* Uhl. (1894) is founded on the winged form of *Rheumatobates* Bergr. (1892), *Rh. Bergrothi* Mein. (1895) from the island of Grenada, being the apterous form of *H. imitator* Uhl. (1894) described from the same island. What Uhler describes as the "long thick coxa" of the hind legs is really the trochanter which in this species is enormously incrassated, forming a much greater mass than the coxa.

As the previously known species of the genus are inadequately described in several points I here append a key to the species. Knowing the winged form of but one species, I refer below only to the apterous forms. I have not seen the female of *Rh. imitator* and possessing a single carded male I do not know if the yellow mesosternum in this species is unicolorous or spotted.

1 (6) Mesonotum with a median yellow spot. Connexivum bright yellow, sometimes more or less infuscated Eyes not reaching the mesopleura. The three last ♂ antennal joints inserted in the apex of the preceding joint in the usual normal way, first joint with a slender spine beneath near the middle, unarmed above, its upper margin straight, third joint with the basal part more or less strongly curved, the apical part straight with a shallow spongy pit on the posterior side. Middle femora in the ♂ straight, unarmed, fringed with long hairs on the inner side, tibiae also fringed with hairs on the inner side.

2 (3) Mesonotum much broader than long. Second ♂ antennal joint with a slender spine beneath near the base, third joint with a strong triangular tooth at the basal end of the not dilated spongy pit, the lower margin of the pit beset with stiff hairs, fourth joint much shorter than third, straight, unarmed. Middle coxae in the ♂ not thicker than the hind coxae, trochantera many times smaller than the hind trochantera, femora fringed with long hairs on the inner margin near the base and apex, the remaining part glabrous, tibiae somewhat curved in the middle where they are thickest, from the base to near the middle fringed on the inner side with short curved hairs, then along a shorter space with long hairs. Hind trochantera in the ♂ excessively incrassated, much broader and thicker than the coxae and femora, armed with a stout spine on the upper side, longly and thickly pilose on the inner side, femora incrassated and curved with a strong tooth on the upper side before the middle and a curved chitinous process on the inner side behind the tooth, near the apex on the

same side with an other linear chitinous process (apparently made up of hairs glued together), tibiae rather stout, slightly curved, the inner margin with scattered hairs from the base to the middle, behind the middle fringed with long hairs.
imitator Uhl.

3 (2) The spongy pit of the third ♂ antennal joint dilated on the under side, its lower margin studded with spinules, fourth joint armed with a spine. Middle coxae in the ♂ thicker than the hind coxae, trochantera not or scarcely smaller than the hind trochantera, femora fringed with long hairs along the whole inner margin, the longest hairs being in the middle, tibiae straight, their basal half thicker than the apical half. Hind trochantera not incrassated, unarmed.

4 (5) Mesonotum conspicuously broader than long in both sexes, the median yellow spot not or scarcely narrower than the pronotal spot. Mesosternum yellow, unicolorous Second ♂ antennal joint beneath with a slender spine at the base, the curved basal part of the third joint three-fourths the length of the whole joint, the spongy pit occupying only the apical fourth with a short spinule at its base, fourth joint about half the length of the third, curved from the base to the apex with the spine in the apical half Middle tibiae in the ♂ fringed with rather short hooked hairs on the inner side of the basal half Hind trochantera in the ♂ rather thickly pilose above, femora incrassated and strongly curved, fringed with moderately long hairs on the inner side near the base, the apex with two bunches of long hairs glued together, tibiae rather stout, a little curved, attenuated at the base and inserted before the apex of the femora in their outer side, fringed with rather short and stiff straight hairs on the upper inner side and emitting a backwardly directed fascicle of very long hairs glued together from a point somewhat behind the base on the inner side. *Rileyi* Bergr

5 (4) Mesonotum scarcely (♂) or slightly (♀) broader than long, the median yellow spot distinctly narrower than the pronotal spot Mesosternum yellow with the anterior margin and two posteriorly diverging bands brownish black, these bands not reaching the posterior margin, dilated near the anterior margin. Second ♂ antennal joint beneath at the base with a small tubercle bearing a fine hair (not visible when the joint is strongly deflected), the curved basal part of the third joint one-half the length of the whole joint, the spongy pit occupying the apical half with a long slender spine at its base, fourth joint scarcely shorter than third. curved near the base and at the extreme apex with the curved spine in the basal half Middle tibiae in the ♂ fringed with short hooked hairs on the inner side from the base almost right to the apex. Hind legs in both sexes simple, straight and hairless. *tenuipes* Mein.

6 (1) Mesonotum much broader than long in either sex. without a median yellow spot. Connexivum velvety black. Eyes reaching the mesopleura. Second and fourth antennal joint in the ♂ inserted rectangularly in the side of the apex of the preceding joint, first joint with a submedian spine above and beneath, its upper margin sinuate behind the middle owing to the apical part of the joint being strongly upturned, second joint beneath at the base with a stiff hair (not visible when the joint is deflected). third joint with the short basal part straight, the curved apical part considerably thicker than the basal part and more than two thirds the length of the joint with a very shallowly impressed almost flat spongy pit, the lower margin of the pit with some stiff hairs and its base with a short tooth-like projection, fourth joint a litte longer than third, unarmed, rectangularly curved

not far from the base. Middle coxae in the ♂ much thicker than the hind coxae, trochantera convex and thicker than the linear hind trochantera, femora hairless, slightly curved, incrassated towards the base, on the inner side with a spine a little before the apex and a short spur just by the apex, tibiae very strongly curved at the base with a tuft of short hairs on the inner side of the end of the curve, between which point and the apex the tibiae are straight and fringed with rather short straight hairs on the outer side of the middle part. Hind legs in both sexes simple, straight and hairless *praeposterus* Bergr.

The genital segments show much the same structure in all the species.

The following are the salient characters of the macropterous form as represented by two winged specimens (♂ ♀) of *Rh. tenuipes* in my collection: Pronotum prolonged backward, covering the mesonotum, the posthumeral part forming a subtriangular process with slightly rounded sides and rounded apex; a blunt transversal keel between the humeri but not reaching them and a median longitudinal impression between this keel and the pale apical spot; an impressed line inside the lateral and posterior margins. Scutellum half-concealed under the posterior end of the pronotal process, blunt and callous at apex. Hemelytra very much longer (♂) or moderately longer (♀) than the abdomen; corium membranous but well separated from the membrane, greyish white, with brown veins, costal margin thickened, subcostal vein very fine, abbreviated towards the base, in the female not discernible or coalescing with the costa, discal vein furcate at apex, the short outer branch joining the costa a little before its apex, the long inner branch running straight to the inner apical angle joining the base of the inner vein of the membrane, apical margin a little oblique, the outer apical angle slightly obtuse, the inner slightly acute; clavus narrow but distinct throughout its length, greyish white with a short brown basal vein barely passing the apex of the scutellum; membrane distinctly (♂) or slightly (♀) longer than the corium, smoky, with an outer and inner vein forming a loop and a median fold-like greyish white vein. Wings considerably (♂) or a little (♀) longer than the abdomen, shorter than the hemelytra, smoky, the veins arranged and colored as in the membrane.

The veins of the corium are thus arranged much on the same plan as in the genus *Trepobates* and those of the membrane are practically identical in the two genera and very different from the veins in the subfamily Gerrinae.

I have not seen the winged form of *Rh. Rileyi;* a figure of it is given as a frontispiece to the last parts of the Proc. Ent. Soc., Washington.

What Uhler describes as the "narrow, almost linear corium" in the winged form of *Rh. imitator* is evidently not the whole corium, but only the space between the discal vein and the costa.

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THE CENTROSOMES OF MARCHANTIA POLYMORPHA.*

JOHN H. SCHAFFNER.

Since Ikeno reported the presence of centrosomes in the antheridial cells of Marchantia polymorpha, in 1903 and 1904, his results have been disputed by several investigators. Ikeno found centrosomes at the poles of the spindles in all the generations of antheridial cells and also observed that these bodies are at the poles of the last division spindle, where they begin to be transformed into the bodies, the so-called blepharoplasts, from which the flagella of the spermatozoid are developed. He came to the same conclusion, therefore, as Belajeff had several years before, through his studies on Gymnogramme and Marsilea, that the blepharoplast is a centrosome.

Miyake, in 1905, failed to see centrosome-like bodies at the poles of the division spindle of the antheridial cells of Marchantia except in the last division, i. e., in the spermatozoid mother cells. From this negative evidence he concludes that Marchantia has no centrosomes. He says: "But my present study seems to show that there is no true centrosome at least in the Hepaticeae, agreeing with the conclusion of the recent studies of Gregoire and Bergh. The centrosome hitherto reported in the cells of the Hepaticeae are nothing but a center of cytoplasmic radiation." It is difficult to imagine how one is to distinguish between "true centrosomes" and "centres of cytoplasmic radiation," especially when the bodies in question are situated at the poles of the spindle.

Ikeno, in reply to Miyake, firmly maintains his former position as follows: "Notwithstanding the contrary statement of Miyake, I have no doubt about the real existence of the

*Contributions from the Botanical Laboratory of Ohio State University, XXXVII

centrosomes in question and so it seemed to me to be quite unnecessary to look for them once more Nevertheless, in order to make my assertion much firmer, I made, soon after his (Miyake's) paper came into my hands, a special re-examination of my slides and could refind easily almost all stages of centrosomes figured in "Taf" III, of my last paper"

Ikeno showed his slides to Dr K Toyama, a zoologist, who was able to see the centrosomes without difficulty He thus comes to the conclusion that the bodies which he calls centrosomes are evidently distinct and constant structures in the antheridial cells of M[illegible]ntia

[illegible] ame subject in 1907, makes the following [illegible] rpuscules du Marchantia polymorpha [illegible] somes, les porteurs de cils"

[illegible] the occurrence of centrosomes in [illegible] 1902 [illegible] ppears to have been the first to find [illegible] in [illegible] cae and his methods seem to have [illegible] than some of the later attempts in the [illegible]

In 190[illegible] rted centrospheres with conspicuous radiation [illegible] s of Marchantia These centrosomes were observed [illegible] stalks of the archegoniophores He says [illegible] ubtedly to exert a great attractive force [illegible] hich certain of the cell contents are drawn [illegible]"

[illegible] methods as Ikeno But different [illegible] have given different results It is curi[illegible] methods I was able to obtain results simil[illegible] were Miyake and Escoyez not able to [illegible] staining processes so as to get the same appearances as Ikeno and myself? It is evident that in micr[illegible] personal equation is large and similar methods [illegible] not [illegible] results to all who use them Therefore, it is [illegible] to destroy positive evidence by negative results [illegible] one cannot produce the positive which others are able to obtain.

After [illegible] Ikeno's first paper, I prepared a large number of slides of the [illegible] idiophores of Marchantia grown in the green house. The material was killed in the weak chromacetic acid solution, and stained on the slide in various ways. After [illegible] I found that I could get the best results by [illegible] safranin and gentian violet and then restaining in [illegible] haematoxylin. About one hundred of w[illegible] be the best slides were selected for study. It was [illegible] however, that in only about ten of these had the staining [illegible] been done well enough to bring out clearly

the minute structures desired. Accordingly, the observations were made on these ten best slides.

The nuclei of the antheridial cells are only 2–3 microns in diameter and all the cell structures are, therefore difficult to see unless one has good natural light, good slides, a good microscope, and good eyes.

In my preparations, I found centrosomes in the antheridial cells of all stages. In the very early or incipient stages of the antheridium, the cells are somewhat larger but not so clear as in the last stages. The staining must, therefore, be very favorable before many details can be seen. It is not always easy to determine the generation of any given set of cells. Nevertheless, one can come to a fairly good approximation and the exact stage is not of especial importance. The final division and the one preceding can of course be determined without difficulty.

When nuclear division begins, cytoplasmic radiations appear at opposite sides of the nucleus. These asters have very dark-staining centers. These centers are the poles of the future spindle. Their appearance is shown in figures 1, 5, and 22–24. Figure 1 is from a very young antheridium, figure 5 is a great grandmother cell or an earlier stage, while figures 22–24 are spermatozoid mother cells in the final process of division. In the later stages the asters are not developed to any extent while in the earlier generations they are very conspicuous. The same is true for the mother star stage as will appear from an examination of the figures. The most beautiful asters and centrosomes were observed in mother star stages of great grandmother cells (Figs. 10–13). The centrosome is often surrounded by a hyaline zone, the attraction sphere, and the aster is a prominent dark-staining structure forming a cloud-like halo (Figs. 11, 12).

In the daughter star stage the centrosome appears elongated or somewhat double, being probably in the first stage of division (Figs 4, 14, 15, 20).

In the later stages of the division of the spermatazoid mother cells to form the two spermatids, no doubling of the centrosome was observed (Figs. 31–40) although it becomes elongated and a double nature is probably shown by the development later of the two flagella.

The centrosome appears to begin to enlarge somewhat even in the grandmother cells and in the last division, which is diagonal as Ikeno discovered, the cells become comparatively clear and the centrosome enlarging still more is thus especially conspicuous. As reported by others, the chromosomes were found to be eight in number in the gametophyte (Fig. 25).

As stated above, after the final division the centrosome becomes elongated and appears as an oval, dense, dark-staining body from which the flagella develop. It is evident that this

enlarged centrosome or blepharoplast is of exactly the same nature as the centrosomes at the spindle poles in the earlier divisions. In the antheridial cells of Marchantia, therefore, we have normal centrosomes appearing at each division from the very earliest stages through the great grandmother, grandmother and mother cell stages preceding the formation of the spermatozoids and according to Van Hook they are also present in the vegetative cells.

The lack of prominent asters in the last division is no doubt due to the decrease in size of the cell with corresponding decrease in the amount of cytoplasm. There is not sufficient space or material in which an aster could be developed.

It is needless to give further observations, for they would only be a repetition of the observations so thoroughly reported by Ikeno. In conclusion it is only necessary to repeat that anyone with proper perseverance may obtain preparations which will verify the results here given; and further it is evident that the blepharoplast of Marchantia is only a slightly modified centrosome which can be traced back through many cell generations and which is probably present in all the cell divisions of the entire ontogeny.

This study was completed at the Botanical Garden of the University of Zürich, and I desire here to express my thanks to the director, Professor Dr. Hans Schinz, for many favors shown me while working in his laboratory.

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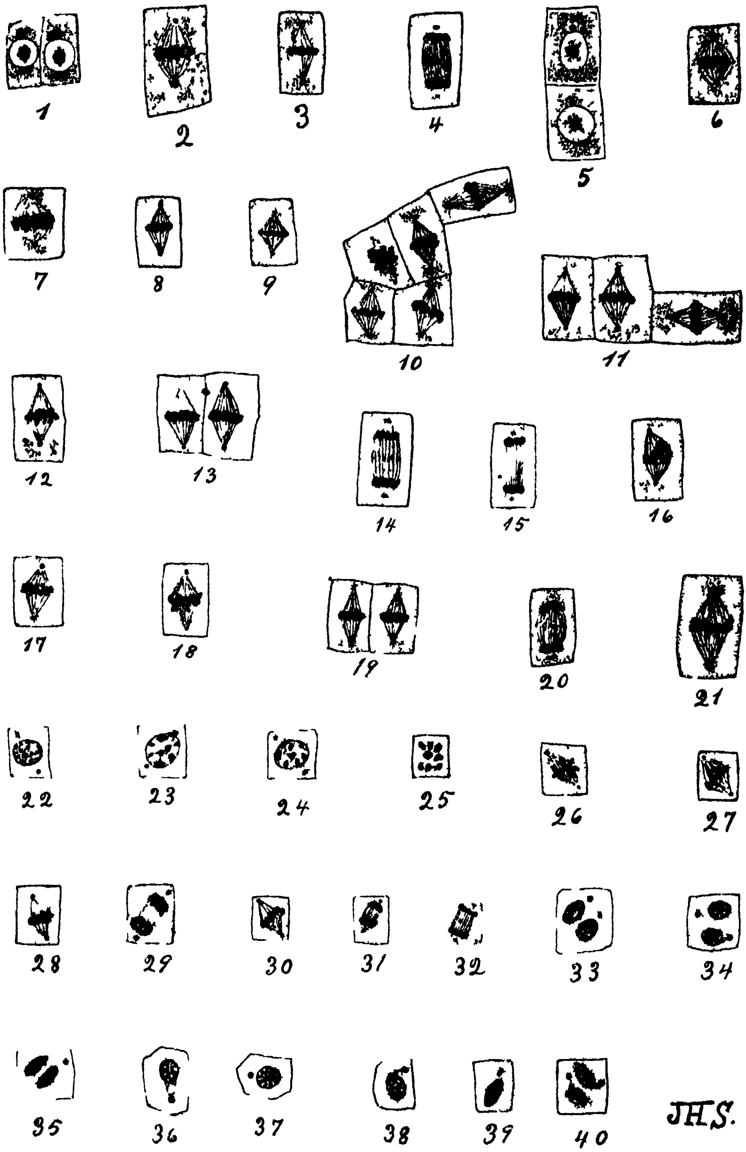
OHIO NATURALIST

Plate XXI.



Schaffner on Centrosomes of Marchantia

EXPLANATION OF PLATE XXI.

The drawings were made with a No. 12 compensating ocular and a 1-12 oil immersion objective, the original magnification being 2250 except figure 21 for which a No. 18 compensating ocular was used. The plate is reduced one-third in reproduction.

Fig. 1. Two cells from a very young antheridium, showing centrosomes on opposite sides of the nucleus.

Figs. 2-3. Mother star stage from a very young antheridium, with centrosomes at the poles.

Fig. 4. Daughter star stage showing elongated centrosomes, from very young antheridium.

Fig. 5. Great grandmother cells, or earlier, showing centrosomes on opposite sides of the dividing nuclei.

Figs. 6-9. Great grandmother cells, or earlier, with centrosomes at the poles of the spindle.

Figs. 10-15. A series of great grandmother cells, showing the appearance of the centrosomes and in some cases dark-staining asters.

Figs. 16-20. Grandmother cells in various stages of division, showing centrosomes at the poles.

Fig. 21. A grandmother cell with prominent centrosomes

Figs. 22-32. Spermatozoid mother cells in process of division, showing the same kind of centrosomes as are in the earlier divisions. Fig. 25 shows eight distinct chromosomes.

Figs. 33-40. Spermatids or incipient and young spermatozoids, showing the increase in size of the centrosome (blepharoplast) as it is being transformed into an elongated cilia-producing organ.

THE BROKEN HEMELYTRA IN CERTAIN HALOBATINAE.

J R DE LA TORRE BUENO

In his description of *Telmatometra** Dr. Bergroth notes that the membrane of the hemelytra being broken off near its basal margin, a description of its veins was not possible. At first I attached no significance to this and assumed that the membrane, being delicate, had been lost in some way. However, a short time after the appearance of the paper cited, a possible explanation presented itself. To me, it clears up the question completely and exhibits a very remarkable habit in certain Halobatines.

While out rowing on St. Mary's Lake, in the vicinity of White Plains, N. Y., on July 4, I noted close to the shore in a little cove made by some rocks, quite a colony of *Trepobates pictus* H. S., adults and nymphs. A scoop of the net yielded a goodly catch, among them one winged individual. In another similar cove, two more were secured from among a large number of the apterous form. These, being of opposite sexes, were preserved alive and set apart for breeding. On the 6th I was obliged to kill them, owing to the remarkable antics of the male. At first, he was noticed fussing with his wings, passing his hind legs under them repeatedly. Very soon he had one hemelytron so bent that the end (the membrane) stood straight up from the body. He continued these passes, so I imagined, to straighten the wing, but finally he succeeded in breaking off first the membrane of one hemelytron and then of the other, leaving the hemelytra in the condition Dr. Bergroth notes in *Telmatometra*. When the females began similar tactics, both were put in the cyanide bottle, because the winged form of *Trepobates* is so rare in these northern latitudes, that until I caught these three, I had taken only one other macropterous individual in eight years' collecting.

At the same time I also secured one ♀ *Rheumatobates rileyi*, fully winged, the only one I have ever seen. This commenced a like de-alating operation, and she, too, was promptly despatched.

A week later I captured no less than seven *Trepobates* with wings similarly broken off, (but only partly so in one individual), three of them being males and the remaining four females. Four *Rheumatobates* were secured at the same time and place, three females and one male, with hemelytra and wings broken off as in *Trepobates*. At a later date one more truncate winged Trepobates was found. All these occurred on a pond about a mile and a half from St. Mary's Lake, in which there had been neither *Trepobates* nor *Rheumatobates* earlier in the summer.

*Ohio Nat., 1908, Vol VIII : 375.

All this led me to make an examination of the various Halobatine forms in my collection to find if any other had a similar peculiarity, which gave the following result:

Of 37 winged *Trepobatopsis denticornis*, Champ., collected by Prof. James S. Hine in Guatemala, 11 being males and 26 females, all have truncate tegmina with ragged edges, showing that the membrane has been broken off.

The thirteen *Trepobates pictus* collected by me locally in the last two summers gave nine individuals with artificially shortened wings, five males and four females, including the one that broke off its wings in the aquarium and one or two others with the wings only partly broken off. The very few winged *Rheumatobates rileyi* I possess, eight specimens in all, gave seven with shortened wings, the males being four and the females three. In *Telmatometra whitei* Bergr., all six types (1 male and 5 females) as Dr. Bergroth points out, have the membrane broken off, not near, however, but *at* the basal margin. In all the examples before me, the break is at the caudad margin of the corium, leaving intact the corial venation.

In *Rheumatobates*, the suture separating the membrane and corium appears as a whitish impressed line, or rather, groove, which is practically straight and crosses the tegmina from edge to edge, just caudad of the termination of the corial venation. The figure (1) is from a winged female *Rh. tenuipes* Mein. from Glen Echo, Md., which I owe to the kindness of Mr. O. Heidemann. It is, of course, largely diagrammatic, although drawn under the microscope by the aid of a camera lucida. It serves to show the general trend *a-b*, of the suture along which the break takes place. This indented line is present in the two species known to me in the macropterous form.

In *Trepobates pictus* there is a similar suture (Fig. 2, a-b), but it differs from that in *Rheumatobates* in that it does not go all the way across the hemelytron, but stops some distance from the submarginal vein, in a sort of node (not shown in figure). It also has a raised appearance, something in the nature of a true vein.

The hemelytra break off along this suture in both *Trepobates* and *Rheumatobates*. This is in all likelihood the case with the monotypic genera *Trepobatopsis* (Fig. 4) Champion and *Telmatometra* (Fig 3) Bergroth, but the lack of entire-winged specimens does not permit confirmation by actual observation.

Naturally, there must be some reason for this self-mutilation, because, unless it be a survival of some acquired habit once necessary in its economy, no insect is given to purposeless acts. Two seemingly reasonable explanations suggest themselves, one of which is closely associated with the breeding habits of the Hemipteron. In the macropterous form of *Rheumatobates rileyi*,

Bergr., *Rh. tenuipes* Mein. and *Trepobates pictus* H. S. the hemelytra extend much beyond the end of the abdomen, being about twice as long as the latter. In all three the male is smaller than the female and has a somewhat shorter abdomen. In consequence the male has to sit quite far back on the female in copulation, in order to approach her genitalia. Now, long wings in the female would be decidedly in the way of the male, as can be readily appreciated, provided they did not actually prevent the generative act altogether. In consequence, the female finds it imperative to shorten her wings in order to give access to the male, which she does by breaking them off at the line of weakness, thereby leaving the greater part of the abdomen exposed. But while this would seem to be an explanation of the act in the female, it scarcely covers the case of the male, since his genitalia are in no way covered or directly prevented from coming into contact with those of the female by his long hemelytra. In the length of the tegmina, however, lies the clew. Both *Trepobates* and *Rheumatobates* rest very close to the surface of the water, so much so that the body of the latter seen from above seems to touch the surface, although when seen from the side it can at once be noted that such is not the case. Now, as pointed out above, the males in both these genera have to sit far back on the females, and in that position the tip end of the hemelytra would produce an indentation in the surface film or be slightly submerged. The smallness of the bug would tend to make it appear that the former would be the case. This resistance, of course, would operate in two ways. It would be a great assistance to the unwilling and struggling female in getting rid of the amorous yet unwelcome male; and it would be decidedly in his way by preventing the approach of his genitalia to hers. Hence the male, for similar reasons to the female finds it necessary to rid himself of members which, while they may at some period subserve a useful purpose, are decided obstacles to the real end of insect life.

The second solution offered in explanation of this self-mutilation is grounded on the following observations.

The first truncate winged *Rheumatobates* I captured was in a deep currentless pool in a stream, by no means a normal breeding place. All the others, as well as the *Trepobates* were found, as previously noted, in a small pond which at a time when St. Mary's Lake had its full quota of both forms in several instars, had not a single individual of either on its placid surface. But later, when the Lake was populous with adults, some fully winged, the pond had on it all these truncate winged individuals as well as a few nymphs and some wingless adults. It may well be, therefore, that the object of the wings is to facilitate migration, either to provide against in-breeding, or to allow their

fortunate possessor to find new worlds to people. In either case, once they have been employed to flee from birthplace to other haunts their mission is accomplished and instead of being a help they become a hindrance to the perpetuation of the species and are better dispensed with, which is done in the manner related. It is quite possible that the apocopated hemelytra in *Trepobatopsis* and *Telmatometra* have a like cause.

It may not be out of place to point out that as the figures show, the corial venation in two of the genera, viz., *Trepobates* and *Rheumatobates* is preserved intact, whence we may deduce that such is the condition also in *Trepobatopsis* and *Telmatometra*. Further, the veins of the membrane in the first two are simple longitudinal ones, and I venture to hazard the opinion that this is their character in the second two. The affinities that this corial venation shows are matters that I am only too happy to leave to others, who are learned in phylogeny.

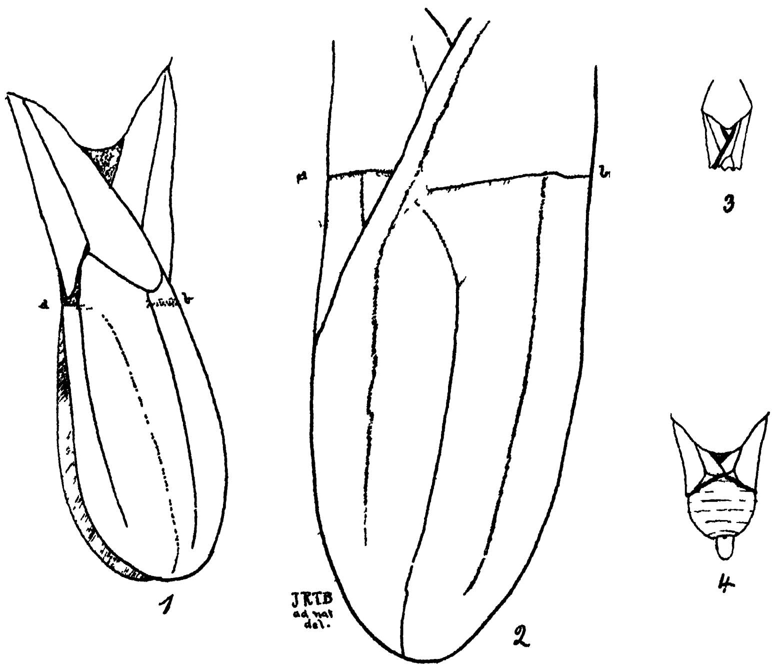


Fig 1. Hemelytra of *Rheumatobates tenuipes* Meinert, ♀, showing the indented suture, a-b, between the Corium and Membrane, along which the membrane is broken off. × 35.

Fig. 2. The same in *Trepobates pictus*, Herrich-Schaeffer. × 35.

Fig. 3. Sketch of Truncate Hemelytra of *Telmatometra whitei*, Bergroth. From one of the types. Shows corial venation. × 3½.

Fig. 4. Sketch of Truncate Hemelytra of *Trepobatopsis denticornis*, Champion ♂. Shows corial venation. × 5.

THE AIR CAVITIES OF EQUISETUM AS WATER RESERVOIRS.

John H. Schaffner.

It is seldom that cavities in vegetative organs serve as reservoirs for holding water. Schimper found that the large intercellular cavities in the swollen spindle-shaped petioles of an epiphytic Aroid, Philodendron cannifolium, are filled with slimy water in wet weather. He also noted that the water gradually disappears from the cavities during a dry period.

Westermaier* described the cavities of Equisteum hyemale and E. telmateja as being full of water in winter and thought that the same condition might be found in summer also. Although Westermaier reported his observations in 1884, this interesting condition in Equisetum does not seem to be generally known.

While walking through a deep ravine near Zürich, Switzerland, the past winter, I found a large patch of Equisetum hyemale in which to my surprise the cavities of the aerial stems were all turgid with water. The central cavities as well as the vallecular and carinal cavities from the lowest to the highest internodes were filled, and this was true for both old and young shoots. In many the water was frozen, especially in the lower joints.

Some plants were pulled up and taken into my living room and by the end of the fourth day the free water had entirely disappeared from the cavities. During January numerous observations were made. Usually the plants were found with cylinders of ice in the central and outer cavities. On January 14, most of the plants examined had little or no water in the central cavities but the vallecular cavities mostly contained cylinders of ice. Favorable plants were taken home and the bases placed in water. In nine days there was still some water in the lower parts of the central cavities of the middle internodes, but above and below the cavities contained air only. Plants with pieces of rhizome still had a little water in the bases of the central cavities on the thirteenth day, but at this time shoots without rhizomes contained air only.

During the middle of May observations were made at Columbus, Ohio, on Equisetum robustum but even after a heavy rain, plants growing in very wet places showed no free water in any of the cavities. If the two species act similarly in this respect, it would seem that the water is present only during the cold period of the year and probably has some physiological connection with

* Westermaier, M. Untersuchungen ueber die Bedeutung todter Roehren und lebender Zellen fuer die Wasserbewegung in der Pflanze. Sitz. d. K. Preuss. Ak. d. Wiss. zu Berlin. 1884: 1105–1117.

the plant in relation to cold and freezing. The water is probably excreted by the cells surrounding the cavities, the membrane lining the central cavity being especially characteristic. It is white and very tough and can easily be removed unbroken from the rest of the tissue.

The Equisetums thus make an exceedingly interesting group for field study in the winter and it might be worth while to make observations on all of our native species

News and Notes.

The eighteenth annual meeting of the Ohio State Academy of Science will be held at Denison University, Granville, Ohio, on November 26-28. A large and interesting meeting is expected.

GRAY'S NEW MANUAL OF BOTANY, SEVENTH EDITION, ILLUSTRATED.* The publication of a new edition of Gray's Manual, extensively revised and modernized by Professor B. L. Robinson and Professor M. L. Fernald, of Harvard University, is an event of unusual interest in the American botanical world. The changes made in the work are such as to make it practically a new book The nomenclature follows the Vienna code; the arrangement of the families is according to the Engler and Prantl scheme; the term family is used in place of the former "order;" and most of the genera have their full quota of recent species. A comparison with Britton's Manual of a few genera shows the following result:

Salix—Gray 31, Britton 51.
Crataegus—Gray 65, Britton 31.
Viola—Gray 45, Britton 43.
Antennaria—Gray 11, Britton 15.

To one who gained his first botanical knowledge from the 5th edition, the present work, therefore, seems altogether new and strange; yet here and there, on close examination, some of the old landmarks are still visible.

The revision has been admirably done, by eliminating the archaic and retaining the best features of the 6th edition. The numerous illustrations have been judiciously selected and will be of great benefit to beginners. The manual will probably become the standard text-book for most of the more conservative botanists of the United States.

No doubt the whole vexed nomenclatural question will again be brought to the front in America. It will now become necessary for those who simply follow some "authority" for convenience to choose between two standards. At first thought

*American Book Company, cloth, 8vo., 928 pp., price $2.50.

one might decide that the only course to take would be to accept the Vienna rules. But no dictum of any convention will probably ever be binding on the conscience of the average American unless all botanists the world over can have a voice in the decision. The only correct scientific convention which legislates for botanists in general must be one organized on the American principle of proportionate representation. In the meantime morphologists and ecologists who use plant names only as a means to an end will not be able to understand each other without the aid of a book of synonyms.

J. H. S.

Correction.

In the paper entitled, "On the Origin of Polar Conjugation in the Angiosperms," February NATURALIST, page 257, line 20, read: "All polar conjugations, according to this view, had their origin in the original conjugation of one or both polars with the second sperm, typically in the second way through triple fusion. The polars acquired the property or function of conjugating with each other through their common attraction to the second sperm.

Now the question arises as to whether there is a triple fusion in Sagittaria and other such cases. Does the second sperm come down later and fuse with the first upper endosperm nucleus after the partition wall is formed, etc.

Meeting of the Biological Club.

ORTON HALL, June 1st, 1908.

The regular monthly meeting of the club was called to order by the president, Dr. Geo. D. Hubbard, at 7:40 P. M. The minutes of the last meeting were approved as read.

The first paper of the evening was by Mrs. Alma D. Jackson, who spoke on her thesis, "The Genus Lepidocertes." She mentioned their relation to other Thysanuran forms, their occurrence and size. She also discussed the work done on these forms in attempts to discover whether or not these insects breathe by trachea. They are very sensitive to killing agents of all sorts. The adults moult on an average of every seven or eight days. They perspire freely before moulting. The larval forms are similar to adults in every detail.

The next thesis reported on was by Prof. Durant. His subject was North American Mallophaga. These are wingless insects, chiefly parasitic on birds. Their food consists chiefly of hair, feathers or epidermal scales. The Mallophaga are biting

lice. The most primitive forms have a wide distribution and the largest number of species.

Prof. Griggs spoke of the occurrence of the fern (Asplenium pinnatifidum) at Sugar Grove and of a varying form which as yet remains undescribed.

Prof. Schaffner spoke of finding Lycopodium porophilum at Sugar Grove and mentioned its similarity in the young condition to the common Lycopodium lucidulum.

The committee of three, W. C. Morse, Miss Edna McCleery, and Prof. J C. Hambleton, appointed to nominate persons for the staff of the OHIO NATURALIST for the year 1908-1909, reported the following nominations:

Editor-in-Chief, John H. Schaffner.

Business Manager, James S. Hine.

Assistant Business Manager, Geo. D. Hubbard

Associate Editors· Botany, Robert F. Griggs; Zoology, H. H. Severin; Geology, W. C. Morse; Archaeology, W. C. Mills; Ornithology, J. C. Hambleton; Geography, G. D. Hubbard.

Advisory Board: Herbert Osborn, John H. Schaffner, Chas. S. Prosser.

On motion, the report of the committee was adopted and the nominees declared elected.

H. S. HAMMOND, *Secretary.*

Date of Publication, November 12, 1908.

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TABLE OF CONTENTS.

ROCK TERRACES ALONG THE STREAMS NEAR COLUMBUS, OHIO.[1]

GEORGE D. HUBBARD.

Several striking terraces of solid rock occur along the Scioto and Olentangy valleys in the vicinity of Columbus. Their character has been revealed in the physiographic study of the four local quadrangles, a study recently undertaken by the Geological Survey of Ohio. They are related to the problem of the post-glacial, and in some cases of the earlier development of these valleys; and it has seemed best to abstract from the material collected in the general study all the data bearing on the rock terrace problem.

So far as the quadrangles[2] involved are concerned, the terraces may be found, ten or more in number, at intervals along the Scioto from the property of the Insane Asylum west of Columbus to the northern boundary line of the area; and four or more, along the Olentangy from near Powell to the same line. There are also the beginnings of several rock terraces along the Big Darby valley.

The Scioto is on bed rock essentially all the way from the northern boundary to the old quarries north of the Asylum; and the Olentangy is similarly restricted from the same boundary on the north almost to Worthington, with occasional rock encounters from there to well within the city limits. The Big Darby has encountered rock at numerous well distributed points from just below where it enters our area to a point midway between

1. By permission of the State Geologist. Read before the Ohio Academy of Science, Granville, O., Nov. 28, 1908.
2. Dublin, Westerville, East Columbus, and West Columbus.

Georgesville and Harrisburg, and again at the latter place. The rock is all of Devonian age; two rather resistant limestones—Columbus and Delaware—and two much less resistant shales above—the Olentangy and Ohio.

Along the Olentangy from south to north the terraces may be described as follows.

West of Lewis Center and across the Olentangy, i. e., on the west side of the river, occurs a terrace about one mile north and south and from 200 to 300 yards wide. Its top stands 30–40 feet above the river, descends perceptibly toward the river, and over 20 feet from north to south. The top is quite uneven being rather heavily mantled with gravel, sand and fine alluvium in piles, ridges and bars. Altho the top is so thoroly covered, the terrace front presents solid limestone rock at several points along the river. The stream is undercutting at only one part of the front. In places, the bluffs at rear of the terrace are not sharp, but are old and gently inclined and support continuous cultivation. This condition of the bluff above the terrace is due to the age of the terrace and the considerable dissection to which the bluff has been subjected. Age of the terrace is attested not only by the condition of the bluff behind, but by the height of the terrace above the river. A flood plain occurs near stream level below the terrace most of the length of the front. Relation of this terrace top to rock structure below could not be made out owing to thick alluvial covering; but the same covering gives the terrace a certain cultural value. A church and cemetery, school-house and several good dwellings surrounded by productive farms may be found upon it, while several even larger nearby tracts are much less used.

One mile east of Hyattsville and across the Olentangy, a small rock terrace about three-eighths of a mile north and south and from a few yards to possibly 200 yards in width, descends gently toward the river with a slope of about 30 feet at widest part and with its edge not more than 20 feet above the water; almost bare rock, but partly covered with a thin sheet of alluvium. Rock is exposed along water's edge nearly the entire length. Terrace consists of the Delaware limestone, but its top is in no measure coincident with structure. A quarry has recently been opened in it.

Less than half a mile farther up the river on the same side, occurs a fine rock terrace over one and one-fourth miles long and about 300 yards wide at the broadest part, tapering considerably northward. The broad part is over one half mile long. The terrace front rises about 20 feet above the river, and the terrace top rises from the crest toward the bluff only about 20 feet which makes the form a very level-topped terrace. Rock is exposed continuously along the terrace front; and the river parallels it

closely today, but leaves a narrow flood plain at its base. Eastward behind the terrace rises a seventy-five foot bluff with a steep serrate front, Bluff largely of Ohio shale, occasionally exposed, with Olentangy covered at the base, Terrace consists of Delaware limestone apparently near top of formation, from which the shales have been swept together with a little Delaware. No quarries are opened in it, but a wagon road runs its entire length.

Across the river from the last and extending some distance farther north, occurs a low, long, narrow terrace. It has a length of one and one-half miles and a width of from 10 to 100 yards, and its front rises only 10–15 feet above the river. The top descends very gently toward the river and also descends 15–20 feet from north to south. A thin sheet of alluvium, but very little residual waste, on top. Many little runs descend across it, mostly on rock. Terrace front almost one continuous outcrop. Terrace is composed of Delaware limestone, and its top is a structural plain, being almost exactly coincident with the bedding planes. A good highway follows it from end to end.

This terrace descends at its southern end so low that high water rises over it, and it thus becomes flood plain for about one mile beyond the point where it is distinctly a terrace above the river. Thus treating flood plain and terrace together, since they are one, we have a rock platform two and a half miles long with its southern end only 5–6 feet above the stream, while its northern end is very nearly 30 feet above; and adding to this difference of 24 feet, the fall of the river in the same distance, about 20 feet, the terrace top is shown to descend about 45 feet in 2½ miles, and more than twice as much as the present stream falls. It follows therefore, that it must have been carved when the grade of the stream was much greater at this place than it is at present.

Passing now to the Scioto near the northern boundary of the area, there are three small terraces between Bellpoint and Rathbone. The first is on the west side a mile or more south from Bellpoint, and is almost 600 yards long and 200 yards wide. It stands 15 feet above the river; its surface descends eastward 15–20 feet toward the river and 10 feet southward down stream. It consists of limestone, and coresponds very closely with the bedding planes. A quarry opened in it.[3]

Across the river and lying just south of the above terrace is another of about the same size. It stands 25 feet above the river, descends gently southward but not toward the river. Two residences upon it.

Passing back to the west side and down stream a hundred yards, another long terrace may be found having a width of

3. Geol. of Ohio, Vol. II, p. 294.

100–200 yards. It is almost level each way, but descends about 10 feet toward the river. It stands 20 feet above the river, and a steep serrate bluff rises back of it. Its top is a structural plain. All three of the above terraces have nearly continuous rock fronts, and quarries have been opened in two of them.

Next down the river is the long narrow terrace on the west side just south of Rathbone. It is nearly one-half mile in length, descends 10 feet southward, but is almost perfectly level from back to front. It stands 20–25 feet above the river with much outcrop on terrace front. An excellent structural plain.

A mile farther down stream and on the east side may be found a rock terrace nearly one mile long and from 50 to 150 yards wide, 35–40 feet above the river, slopes gently toward the river, and descends 15–20 feet in its length. Only one other terrace studied is as high above the river as is this one.

Opposite Dublin occurs a strong rock terrace about three-fourths mile long and from 20 to 200 yards wide. Its top is 30–40 feet above the river and remarkably level, descending southward or down stream about 10 feet in its length. Some of the top is nearly bare; other parts are mantled with alluvium. Terrace front is a rock outcrop. A quarry long ago opened in the terrace near the Dublin bridge furnished building stone and lime, the latter being burned in kilns on the terrace.

On east side of Scioto just south of Hayden's run, may be found an interesting terrace over one-half mile long and 100–200 yards wide with its top full 40 feet above the river and very level. In northern half is much washed, calcareous gravel, but in southern half very little, usually none. Rock shows in terrace front in several places. Bluff rising behind the terrace is of limestone at base and deeply covered with drift. About in middle of bluff and 15–20 feet above the terrace top are fine glacial striae on limestone.[4] These striae are about 800 feet above sea level and 100 feet below the upland surface of the vicinity. Bed rock occurs in Slate run to the south and in another run to the north 25–50 feet above the striae. There seems to be a buried valley here but it can not have been as deep as the present Scioto valley. It must have been as deep as the top of the striated ledge and it may have been as deep as to the terrace top. The gravel being largely calcareous and only locally developed is probably of post-glacial origin. Of course, if it were laid as glacial outwash, the terrace top upon which it lies must represent the bottom of an older valley. No striae have been found on any of the rock terrace tops. The gravel has been opened and worked at two points, and a quarry and crusher are in operation in the southern part of the terrace.

4 Reported by W. C. Morse in 1906.

A magnificent rock terrace on the east side nearly one and one-half miles long lies between the Columbus Fishing Club pond on the north, and Fishinger's Bridge on the south. It narrows toward the north, but attains a width of a fourth mile in its central and southern parts. The terrace top averages about 70 feet above the river and has relief of 20–30 feet. The highest part is central, and the rock surface descends eastward as well as westward, northward as well as southward. South of the central higher part a depressed contour surrounds ten acres, and beyond the depression near the private road occurs a true sink hole. A little washed gravel is found on the terrace top, notably at the south, but in no abundance. Soil on the terrace top is otherwise thin, cherty alluvium. The terrace front is a continuous rock bluff, sometimes precipitous. The bluff behind this terrace is all of drift; and the rock below the drift is lower than in the terrace top, as is revealed by well records and by the absence of rock in the ravine east and southeast of the terrace. One well east of terrace goes almost 40 feet below the terrace before reaching rock. A large alluvial pan of modified drift built upon the terrace argues for its age.

By way of interpretation, it is suggested that before the last ice sheet overspread this region there was a valley lying eastward at this point from the present Scioto which had attained a depth within 30 feet as great as the present valley; that this valley became drift filled, and then the glacial drainage, and subsequently the present Scioto, took their course across the drift plain. After cutting down for some time and sweeping off the drift, the stream found itself on the rock of the terrace, a portion of the western side and bottom of the filled valley. Instead of sliding eastward into the old valley, the Scioto began down cutting in the rock on the western side of its valley, and thus carved the present gorge 70 feet deep below the terrace top. It has not been determined whether the sink hole mentioned, belongs with the post-glacial drainage system or not, but it is believed that it was formed before the last ice advance.

The largest terrace of all lies on the east side of the Scioto, begins about three-fourths mile down stream from the large storage dam and continues down stream 2½ miles or practically to the big bend in the river, where it turns eastward around Marble Cliff to receive the Olentangy. This terrace varies in width from a few yards to about 300 yards. At its upper end, it rises 25–30 feet above the river, but descends gently southward to less than 20 feet above. Some of the terrace top slopes toward the river, but north of Fifth Avenue a considerable area is quite level and coincides with the rock structure, the bedding planes, quite closely, and hence here might be called a structural plain. In some places, the terrace top is well mantled with

alluvium, but usually the layer of cherty clay is quite thin, and the rock is exposed in roadways, railroad cuts and brook beds. The terrace front is steep and practically continuous rock outcrop. The bluff to the east of the terrace contains Ohio shale which has been seen in several exposures, and below it the Olentangy, not exposed, but the drift cover above the shale is thick.

In some places, this terrace consists of two steps more or less definitely separated by a little scarp. There is rarely any flood plain below it before the river. It consists of Delaware and Columbus limestone, the former becoming very thin and finally wanting at the south end.

The most important cultural aspect of the terrace, no doubt, is the opportunity it affords for quarrying the limestone. The terrace front has been opened nearly its whole length, and one considerable quarry has been started in its top. The old Smith and Price quarry, several little old ones, and the present Casparis and at least one other small quarry are to be found in the terrace. Part of the terrace top is under cultivation every year, and a small portion is devoted to golf links. The Pennsylvania railroad finds on it an easy grade from the flood plain in West Columbus up to its bridge at Marble Cliff and across to the undissected upland on the west side.

Opposite the west end of Fifth Avenue, is a low rock terrace, the present flood plain 400-500 feet wide and three-fourths mile long. It stands about 15 feet above the river and bears much alluvium especially along its water front so that rock is rarely exposed.

Farther south and on the west side of the Scioto along the big turn toward the east, occurs the most southern rock terrace of this river. It is more than a half mile in length, a hundred yards in width, and stands 20 feet or more above the river. It has been so many times opened for quarrying and modified by erosion that details of its surface form are difficult to obtain. The T. and O. C. railroad swings across it, as also does the highway.

A few more rock terraces were found along the Big Darby. The first is two miles south of Georgesville on the west side, and is about one-fourth by one-eighth mile in size with its top 20-25 feet above the river. This is the only one along the Darby creek that is far above the water.

For two miles south of the intersection of Big Darby with the Columbus and Springfield electric line, a number of miniature rock terraces occur, rising 5-20 feet above the water. This stream has cut thru the drift mantle, but has only begun here and there to cut into rock, hence, it is in a much less advanced stage of terrace development than the two larger rivers. Its terraces are not large, and are never far above the water; but it seems probable that a time will come when the Big Darby will have so

far cut into the rock that its valley shall be ornamented with terraces as are its larger neighbors. Its problem will then, however, be somewhat complicated, if its alluvial terraces shall persist that long, for today the Big Darby has many fine terraces of this more ephemeral type.

In conclusion, a few facts and deductions may be noted.

1. The grade of the rivers has been reduced since the terraces were made. Almost every terrace top is nearer the river level at its downstream end than at the other. And further, an analysis of the slopes of the various terrace tops shows that the higher ones descend downstream most rapidly, and the lower ones but little faster than the present water level. The average fall of the present Scioto across the quadrangle is $6\frac{3}{4}$ feet per mile; that of the Olentangy is $5\frac{1}{2}$ feet per mile—bee line distances. The upper terraces fall 20 feet per mile and some of the lower ones about 10 feet per mile.

2. This relation just noted confirms a statement made earlier in the paper, that the terraces, with two possible exceptions, were made by the present streams. The same statement is further confirmed in the fact that all terraces descend southward or with the present drainage.

3. It has been pointed out that in harmony with the slight eastward dip of the rock and the customary streamward slope of the terrace tops, those on the west side are usually structural plains, while those on the east side are usually not.

4. The terraces are confined to country whose surface rock is limestone, or limestone with a very little shale cover. The shale alone seems not to be adapted to terrace formation. It might be added here that in one side stream good terraces were found consisting of Ohio shale from which the thick drift cover had been removed. The shale proving a much tougher material than the drift the stream has, to date, been unable to make nearly as wide valley in it as was made while still cutting in the drift above. Hence is found a large shale terrace symmetrically disposed on each side.

5. The terraces are of marked economic importance, offering good roadways above flood waters, good building sites above the fertile flood plains but not so far away as sites on the uplands must needs be. Springs frequently occur at the back side of the terrace, making them still more desirable for residences. Finally most of the quarries are in these terraces, because of the excellent opportunities to get at the rock.

THE EFFECT OF ALKALOIDS ON REGENERATION IN THE SCARLET RUNNER BEAN.

SERGIUS MORGULIS

The difference in the rates of growth is undoubtedly one of the most important problems in the study of regeneration at the present time. The problem is now being attacked by a number of zoologists, who study this question from the point of view of the relation of the rate of regeneration to either the degree of injury, or the frequency of injury, or the levels at which the organism is injured.

Although zoologists agree as to what phenomena are to be described under the head of "regeneration," there is still no concensus of opinion with regard to plants; and while Pfeffer (6), for instance, would limit the term regeneration to those cases only "in which an organ replaces a portion of itself which has been removed" (p. 167), Goebel (2) and others contend that phenomena of regeneration imply also a development of dormant or latent buds present before injury.

McCallum (4) finds that of all the plants under his observation there were scarcely any "in which these primordia developed without the removal of the shoot, and in every case in which the stem was cut off they developed."

In an investigation, (now in progress), upon the regeneration of animals, the attempt was made by the writer to study the problem from a new standpoint, that of the modifiability of the rate of regeneration under changed external conditions, with the hope of throwing some additional light upon this somewhat perplexing problem. It seemed desirable, in connection with these experiments upon animals, to test the method also on regenerating plants, especially since the subject of the rate of regeneration, so far as the writer's knowledge goes, does not seem to have been touched upon by botanists. It was important for the purpose in hand to obtain a plant in which the regenerative processes had already been investigated and which at the same time would be available for further experimentation. Such an object was found in the scarlet runner bean, a variety of Phaseolus multiflorus, on which McCallum (4) has done much valuable research, and ascertained many points of importance.

Omitting details, the method followed was briefly this: Seeds of the scarlet runner bean were germinated in sawdust until they had reached a height of 6 cm. The seedlings were then transferred to pint mason jars. Each jar was completely covered with black paper in order to protect the growing roots

Contribution from the Bot. Lab. of Ohio State University, XXXVIII.

from the action of sunlight. There were two plants in each jar, held in place by means of perforated corks which had been previously paraffined. It may also be mentioned that the corks were subsequently paraffined to the jars so as to prevent any evaporation of water except that through the leaves.

The plants were subjected to the influence of a few alkaloids in solutions of various degrees of concentration in order to determine the effect which these substances would produce upon the rate of regeneration of new shoots. The following alkaloids were used: Sulphates of atropine and strychnine, pilocarpine hydrochloride and digitalin, each in a (a) 0.01%, (b) 0.001%, and (c) 0.0001% aqueous solution. Each jar contained 400 cc. of the solution; distilled water was used for the controls. The water in all jars was changed at intervals, and carefully weighed. The full series of plants was kept always in the same place in the university greenhouse so as to insure equal conditions of light, temperature and air currents.

The stems were cut off with sharp scissors very near the base the second day after the plants had been transferred to the mason jars. The rudiments of new stems appeared shortly afterwards in the axils of the cotyledons.

It is known that a close relationship exists between the quantity of transpiration and the amount of growth for a given length of time (3), and that the index of transpiration is usually relied upon in comparing the rate of growth under varied conditions. Since transpiration is a continuous physiological process in living plants it was hoped that such data might aid in obtaining an insight into the physiological condition of plants regenerating under the influence of the various alkaloids. Unfortunately these data do not always prove to be quite a reliable basis for comparison of the actual amounts of regeneration for definite periods; they were therefore checked up by other data, as for instance, the weight of plants. The failure of the indices of transpiration to offer a solid ground for the comparative study of the rates of regeneration in this particular case of the scarlet runner bean is probably due in a large measure to the circumstance that the total surface area of the leaves, the number and form of which differed during regeneration almost with each plant, is not sufficiently uniform; and consequently the amount of water lost through transpiration does not always correspond to the real rate of regeneration. The following table contains data on transpiration:

TABLE I.

Date—February 27, to March 15, 1908

Solution	Transpiration	
	Total	Daily Average
Control I	69 95 grms	4 12 grms
Control II	58 65 "	3 45 "
Strychnine 0 01%	43 95 grms	2 59 grms
" 0 001%	93 10 "	5 48 "
" 0 0001%	91 20 "	5 37 "
Digitalin 0 01%	64 60 grms	3 80 grms
" 0 001%	90 65 "	5 33 "
" 0 0001%	123 30 "	7 25 "
Pilocarpine 0 01%	108 90 grms	6 46 grms
" 0 001%	61 05 "	3 59 "
" 0 0001%	108 55 "	6 39 "
Atropine 0 01%	65 25 grms	3 84 grms.
" 0 001%	61 90 "	3 64 "
" 0 0001%	80 35 "	4 73 "

The illustrations (Figs. 1–4) which are reproduced from photographs of plants that had been regenerating about 8 days after the epicotyls were cut off, will serve for comparing the actual sizes attained by the different plants. Reading from left to right the arrangement of the cultures in the photographs is in all cases as follows: control, solutions *a, b, c*. From these figures it will be seen that the rate of regeneration varies both with the nature of the medium and also with the strength of the solution in which the plants regenerated. In pilocarpine (Fig. 1) the plants developed more luxuriantly than the controls and the greatest acceleration is shown in both the stronger and the weaker solution (0.01% and 0.001%). In solutions of digitalin (Fig. 2) the greatest acceleration took place in the weaker solution, while the regeneration was slower in the strong solution (0.01%). Atropine (Fig. 3) and strychnine act as stimuli only in very weak solutions (0.0001%). In extremely attenuated solu-

tions of atropine and strychnine, such as were obtained by means of filtrating these solutions through lamp black or through calcium carbonate (1), the process of regeneration was augmented to a remarkable degree. Solutions of strychnine (Fig. 4) act differently upon different plants, but the greatest stimulation is caused invariably by the weaker solutions. Stronger solutions, though they may stimulate growth at first, soon become injurious to the plant.

At the end of twelve days after the operation the differences in size of the regenerating plants became much more pronounced than those seen in the figures shown here.

In the following table are given the data concerning the green and dry weight of the plants.

TABLE II.

Solution	0 01%		0.001%		0 0001%	
	Weight of plts. in grs.		Weight of plts. in grs		Weight of plts in grs.	
	Green	Dry	Green	Dry	Green	Dry
Strychnine	2 25	0 56	3.50	0.88	5.00	1.25
Digitalin	3 75	0 94	4.80	1 20	7.70	1.93
Pilocarpine	6 65	1 64	5 05	1 26	5.95	1.49
Atropine	2.95	0.74	2.25	0.56	3 25	0.81
Control I	2.40	0.60				
Control II	1.85	0.46				

It may be seen from this table that the inference which should be drawn from records of the weight of the regenerated stems practically coincides with data obtained from the study of their transpiration and actual size.

On the 15th of March, i. e., seventeen days after the operation the regenerated stems were cut off once more with sharp scissors near their proximal ends. The object in performing this experiment was to find out how the plants would behave in regeneration after a second operation. In a previous work on regeneration in the fresh water oligochaete, Lumbriculus, (6a) it was pointed out that the rate of regeneration in that animal decreases after successive operations, so that if we designate the rate of regeneration after the first operation by a unit, the rate of regeneration after a second operation would be only one-half of a unit, and one-fourth of a unit after the third operation, the length of time during which the animals are allowed to regenerate being, of course, the same in all three cases. Zeleny (8), on the other hand, finds that

Fig. 1. Phaseolus in pilocorpine solution.

Fig. 2. Phaseolus in digitalin solution.

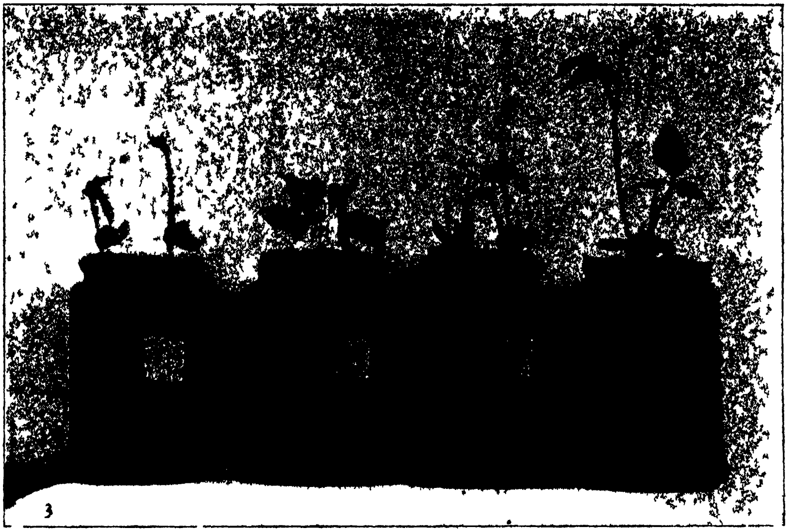

Fig 3 Phaseolus in atropine solution.

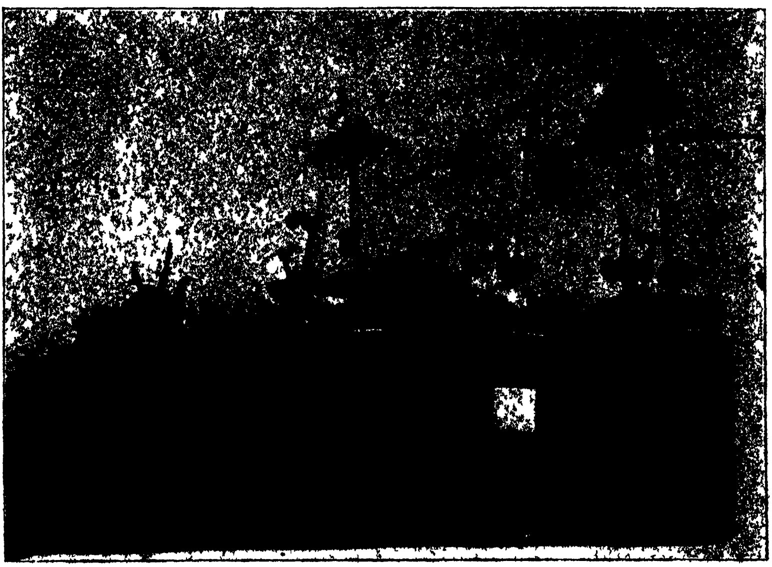

Fig. 4 Phaseolus in strychnine solution.

in the Scyphomedusan, Cassiopea xamachana, "there is a well marked difference between the second and the first regeneration in favor of the former."

A rather long interval followed upon the second operation, before the plants commenced to regenerate again. The new stems were now growing from the axils between the stump of the old epicotyl and the stumps of the regenerated stems that were cut off March 15; and also from the axils between the latter ones and the cotyledons. In other words, in place of the two stems which had regenerated after the first operation there were regenerating now four stems, as may be seen from the accompanying diagram. It should be mentioned, however, in this connection, that the four stems have not always regenerated equally well from each plant.

The following Table III contains data concerning transpiration, weight of all the regenerated material and also extracts from protocols, relating to the condition of the plants:

TABLE III.

March 15 to April 6, 1908

Nature of Solution	Transpiration		Weight of regener tissue	Remarks March 28
	Total	Daily average		
	Grms.	Grms.	Grms.	
Control	48 70	2 21	0.75	
Strychnine 0.01%	14.50*	1.11	.	Dead
" 0.001%	31.15	1.42	0 30	Regen. slightly
" 0.0001%	48.80	2.22	1.05	Regen. well
Digitalin 0.01%	42.50	1.48	0 75	Reg. stems small
" 0.001%	74.25	3.38	1.80	Reg. well
" 0.0001%	108.65	4.94	2.10	Reg. stems large
Pilocarpine 0.01%	62.40	2.84	1.75	Stems reg. well
" 0.001%	22.50	1.02	0.20	Stems small
" 0.0001%	96.75	4.40	1.90	Stems quite large
Atropine 0.01%	39.15	1.78	0.60	
" 0.001%	42.45	1.93	0.85	Stems regen. at fairly good rate
" 0.0001%	53.55	2.44	0.95	

*Total transpiration for 13 days only; the plants died soon afterwards.

From this table it will be observed that strychnine, especially in the stronger concentration acted poisonously upon the plants, checking rather than stimulating their regenerative power. Even a superficial examination of the Tables I and III will leave no room for doubt as to the very large difference between the first and the second regeneration in favor of the former. And in spite of the fact that after the second operation the plants had been regenerating for a longer period of time, the regenerated

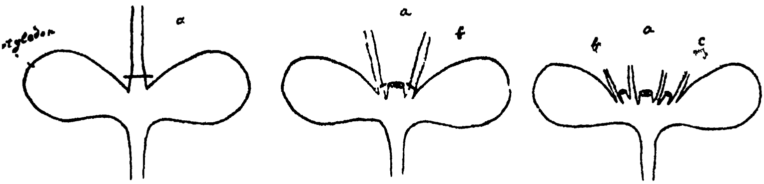

Fig. 5. Diagram of decapitated plants; *a*—old epicotyl, *b* and *c*—regenerating stems.

stems were by far smaller than those regenerated after the first operation. That the difference is not to be attributed to an exhaustion of food materials was evident because the cotyledons were still of a large size. Furthermore, McCallum (4) demonstrated in a series of ingenius experiments that food is not a necessary factor in regeneration of Phaseolus, and that the plants regenerate even with the cotyledons removed

CONCLUSION.

In summing up the facts presented in this note it may not be amiss, perhaps, to discuss briefly their relation to facts obtained in other similar studies. It was shown in the foregoing that alkaloids, such as pilocarpine, atropine, strychnine and digitalin exert a stimulating influence upon regenerating plants, increasing the rate of regeneration. Yasuda (7) found from his study of the effect of alkaloids upon moulds that "the moulds generally grow better in the solutions which contain alkaloids than in the normal control-solution." (p. 82.) He also found that strychnine produced no poisonous action on the moulds until the limit of saturation was reached (about 2.5%). Plants behave somewhat differently in this respect from animals. In a recent work on the effect of alkaloids upon the early development of eggs of the sea-urchin, Toxopnenstes variegatus, conducted at the Bermuda Biological Station (5c), atropine, strychnine and digitalin were found to inhibit the developmental process, the last two substances being so much toxic that normal development was possible only in very dilute solutions. Neither did pilocarpine stimulate or accelerate to any marked degree the development of the eggs of this sea-urchin, although the literature contains a

record to the contrary with reference to the eggs of Asterias Forbesii. With the exception of the stronger solution of strychnine, Phaseolus was able to live in concentrations which would prove fatal to animals.

The effect of the action of these alkaloids upon plants varies both with the nature and with the strength of the solution, but on the whole a general rise and intensification of the vital processes is seen as, for instance, in the augmentation of the function of transpiration, and in the higher rate of regeneration as compared with plants not subjected to the influence of stimulating agents. It seems therefore, legitimate to assume that there exists an intimate relation between the rate of regeneration and the physiological condition of the regenerating organism.

Concerning the rate of regeneration after consecutive operation it is obvious, from the facts cited above, that after the second operation there is a considerable decrease of the power of regeneration and, consequently, a slowing down of the process, as well as a considerable lengthening of the period which intervenes between the operation and the first appearance of regenerated tissue.

The work here recorded was carried on in the Botanical Laboratory of the Ohio State University during the Spring of 1908, with the aid of a grant from the McMillin Research Fund.

It gives me pleasure to express here my gratitude to Dr. A. Dachnowski for much friendly assistance in this work.

Cambridge, Mass., October, 1908.

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PLANTS ON THE OHIO STATE LIST NOT REPRESENTED IN THE STATE HERBARIUM.

JOHN H. SCHAFFNER

There are at present 254 species and varieties of plants on the Ohio State List which are not represented in the State Herbarium at the State University. Some of these are undoubtedly members of our flora but a large number are known to be outside of our region. It is hoped that many may yet be found before the publication of a new check list which is contemplated. The co-operation of all botanists in the state is asked in order that the report may be as complete as possible.

A large part of them, if no evidence is forthcoming as to their occurrence in the state, will be removed from the state list. It is believed that it will be far better to have a list that is reasonably certain than to carry a large number of names which give misleading data on plant distribution. If any are found in the future, they can then be restored to the state list with proper authority.

Ophioglossum engelmanni Prantl.
Botrychium simplex Hitch.
Woodsia ilvensis (L.) R. Br
Dryopteris spinulosa dilatata (Hoff.) Und.
Woodwardia areolata (L.) Moore.
Asplenium fontanum (L.) Bernh.
Equisetum scirpoides Mx.
Lycopodium inundatum L.
" annotinum L.
Sparganium simplex Huds.
Potamogeton hillii Mor.
" friesii Rup.
" vaseyi Robb.
" spirillus Tuck.
" interruptus Kit.
Naias flexilis robusta Mor.
Sagittaria engelmanniana Sm.
" arifolia Nutt.
Panicum xanthophysum Gr.
" liebergii (Vasey) Scrib.
" werneri Scrib.
Zizaniopsis miliacea (Mx.) D. & A.
Oryzopsis juncea (Mx.) B. S. P.
" asperifolia Mx.
Alopecurus pratensis L.
Deschampsia caespitosa (L.) Beauv.
Trisetum pennsylvanicum (L.) Beauv.
Avena fatua L.
Capriola dactylon (L.) Ktz.
Eragrostis trichodes (Nutt.) Nash.
Melica mutica Walt.
Uniola latifolia Mx.
Poa autumnalis Muhl.
" trivialis L
Panicularia obtusa (Muhl.) Ktz.
" pallida (Torr.) Ktz.
" acutiflora (Torr.) Ktz.
Festuca ovina duriuscula (L.) Hack.
Bromus inermis Leyss.
Lolium temulentum L.
Cyperus ovularis (Mx.) Torr.
" dentatus Torr.
Eleocharis interstincta (Vahl.) R. & S.
" palustris glaucescens (Willd.) Gr.
" rostellata Torr.
Scirpus subterminalis Torr.
" cyperinus eriophorum (Mx.) Britt.
Rynchospora corniculata (Lam.) Gr.
Carex haydeni Dew.
" goodenovii J. Gay.
" limosa L.
" gynandra Schw.
" gracillima x pubescens Bail.
" formosa Dew.
" longirostris Torr.
" arctata Boott.
" (granularis) schriveri Britt.
" meadii Dew.

Carex aurea Nutt.
" setifolia (Dew.) Britt
" richardsoni R. Br.
" pedicillata wheeleri (Bail.) Britt
" novae-angliae Schw.
" deflexa Hornem.
" umbrellata Schk.
" durifolia Bail.
" chordorhiza L. f.
" decomposita Muhl.
" xanthocarpa Bick.
" sartwellii Dew.
" muricata L.
" interior capillacea Bail.
" muhlenbergii xalapensis (Kunth) Britt.
" tenuiflora Wahl.
" siccata Dew.
" straminea mirabilis (Dew.) Tuck.
" tenera Dew.
" albolutescens Schw.
" bicknellii Britt.
Xyris caroliniana Walt.
Eriocaulon septangulare With.
Heteranthera reniformis R. & P.
Juncus filiformis L.
" dichotomus Ell.
" stygius L.
" brachycarpus Eng.
Allum stellatum Ker.
Lilium philadelphicum L.
" superbum L.
Clintonia borealis (Ait.) Raf.
Streptopus amplexifolius (L.) D.C.
Trillium undulatum Willd.
Smilax pseudo-china L.
Orchis rotundifolia Pursh.
Blephariglottis grandiflora (Bigl.) Torr.
Achroanthes monophylla (L.) Greene.
Corallorhiza corallorhiza (L.) Karst
" wisteriana Conr.
Tipularia unifolia (Muhl.) B. S. P.
Myrica cerifera L.
Salix alba coerulea (Sm.) Koch.
" alba x babylonica.
Corylus rostrata Ait.
Betula populifolia Marsh.
Quercus texana Buck.
" alexanderi Britt.
" schneckii Britt.
" nana (Marsh.) Sarg.
Broussonetia papyrifera (L.) Vent.
Rumex sanguinea L.
Polygonum cilinode Mx.
" dumetorum L.
Amaranthus crispus (L. & T.) Braun.
Irsine paniculata (L.) Ktz.
Claytonia caroliniana Mx.
" perfoliata Donn.
Silene dichotoma Ehrh.
Lychnis dioica L
Alsine borealis (Bigel) Britt.
Nymphaea kalmiana (Mx.) Sims.
Delphinium carolinianum Walt.
Aconitum uncinatum L.
Trautvetteria caroliniensis (Walt.) Vail.
Ranunculus ovalis Raf.
" micranthus Nutt.
" arvensis L.
Nigella damascena L.
Papaver somniferum L.
" dubium L.
" argemone L
Bicuculla eximia (Ker) Millsp.
Capnoides aureum (Willd) Ktz.
Lepidium ruderale L.
Alliaria alliaria (L) Britt.
Dentaria maxima Nutt
Koniga maritima (L.) R. Br.
Podostemon ceratophyllum Mx.
Mitella nuda L.
Philadelphus inodorus L.
" grandiflorus Willd.
Ribes lacustre (Pers.) Poir.
" nigrum L.
Spiraea corymbosa Raf.
Rubus (villosus) frondosus Bigel.
" setosus Bigel.
Dalibarda repens L.
Rosa cinnamomea L.
Prunus cuneata Raf.
Psoralea stipulata T. & G.
Kuhnistera candida (Willd.) Ktz.
" purpurea (Vent.) Macm.
Lespedeza nuttallii Darl.
" stuvei Nutt.
" angustifolia (Pursh.) Ell.
Phaseolus polystachyus (L.) B. S. P.
Geranium dissectum L.
Polygala incarnata L.
Acer pennsylvanicum L.
Cardiospermum halicachum L.
Parthenocissus quinquefolia laciniata Planch.
Malva (verticillata) crispa L.
Sida hermaphrodita (L.) Rusby.

Hypericum majus (Gr.) Britt.
" canadense L.
Triadenum petiolatum (Walt.) Britt.
Lechea stricta Legg.
Viola pedata L.
Onagra oakesiana (Gr.) Britt.
Lavauxia triloba (Nutt.) Spach
Myriophyllum tenellum Bigel.
" heterophyllum Mx.
Ligusticum scoticum L.
Anethum graveolens L.
Pimpinella saxifraga L.
Eulophus americanus Nutt.
Ptilimnium capillaceum (Mx) Raf
Cornus baileyi Coult. & Ev.
Pyrola uliginosa Torr.
" asarifolia Mx.
Ledum groenlandicum Oeder.
Azalea viscosa L
Kalmia augustifolia L.
Gaylussacia frondosa (L.) T. & G.
Vaccinium pallidum Ait.
Oxycoccus oxycoccus (L.) MacM.
Lymnanthemum lacunosum (Vent) Griseb.
Apocynum hypericifolium Ait.
Asclepias decumbens L
Quamoclit quamoclit (L) Britt.
" coccinea (L) Moench.
Cuscuta epithymum Murr
" compacta Juss.
Phacelia dubia (L.) Small.
Heliotropium indicum L.
" anchusifolium Poir.
Myosotis palustris (L) Lam.
Lithospermum officinale L.
Onosmodium virginianum (L.) D.C.
Lycopus arvensis L.
Ajuga reptans L.
Scutellaria pilosa Mx.
" saxatilis Ridd.
Salvia verbenaca L.
Monarda punctata L.
" citriodora Cerv.
Hedeoma hispida Pursh.
Lycopus europaeus L.
Hyoscyamus niger L.
Linaria canadensis (L.) Dum.
Gratiola aurea Muhl.
Veronica hederaefolia L.
Plantago elongata Pursh
Spermacoce glabra Mx.
Galium vernum L.
Lonicera caprifolium L.
Valerianella woodsiana (T. & G.) Walp.
Valerianella woodsiana patellaria (Sull.) Gr.
Lobelia nuttallii R. & S.
Lactuca sativa L.
Nabalus serpentarius (Pursh) Hook.
Eupatorium serotinum Mx.
Lacinaria squarrosa intermedia (Lindl.) Port.
Lacinaria pycnostachya (Mx.) Ktz.
Amphiachyris dracunculoides (D C.) Nutt
Chrysopsis graminifolia (Mx.) Nutt.
Solidago odora Ait.
" juncea ramosa Port & Britt
" moseleyi Fern
Sericocarpus linifolius (L.) B. S. P
Callistephus chinensis (L.) Cass
Aster divaricatus persaliens Burg
claytoni crispicans Burg
" cordifolius polycephalus Port
" lindleyanus eximius Burg.
" sagittifolius dissitiflorus Burg
" oblongifolius Nutt.
" puniceus firmus (Nees) T. & G.
" acuminatus Mx.
salicifolius stenophyllus (Lindl) Burg.
" ericoides platyphyllus T. & G.
" lateriflorus grandis Port
Helianthus strumosus macrophyllus (Willd.) Britt.
Helianthus atrorubens L.
" (giganteus) ambiguus (T. & G) Britt.
Gifola germanica (L.) Dum.
Silphium laciniatum L.
Verbesina occidentalis Walt.
Bidens elliptica (Wieg.) Gleason.
Matricaria matricarioides (Less) Port.
Artemisia absinthium L.
" abronatum L.
Mariana mariana (L.) Hill.
Centaurea nigra L.
" benedicta L.

Meeting of the Biological Club.

ORTON HALL, Oct. 5, 1908.

The club was called to order by the president and the minutes of the previous meeting were read and approved.

This being the first meeting after the reopening of the University, the program consisted of reports of the past summer's work. The president, Prof. Hubbard, appointed R. F. Griggs, J. S. Hine and J. C. Hambleton as a nominating committee to nominate candidates for officers for the coming year.

Dr. A. Dachnowski reviewed the ecology of Cedar Point, having studied the succession of vegetation in the lagoons Prof. R. F. Griggs reported finding an interesting division of nuclei in Synchitrium. Prof. J. H. Schaffner gave an interesting account of his past year's study in Europe. Mr. R. J. Sim gave an account of observations on the food habits of the black tern, which seems capable of consuming enormous quantities of minnows at one time. Prof. J. C. Hambleton spoke of the reforestation of old farms and hills of New England. The new growth is largely pine. Prof. F. L. Landacre reported on recent studies of his on the brain of the cat fish. Mr. W. C. Morse was engaged the past summer in a study of the geology of southern Ohio and Kentucky, the work in the latter state being in the Bedford and Berea. Prof. H. Osborn gave an account of the work at the Lake Laboratory at Sandusky the past summer, mentioning the extension of the bird records for Ohio by Prof. L. Jones.

ARTHUR H. MCCRAY, *Secretary.*

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TABLE OF CONTENTS.

RECENT EVAPORATION INVESTIGATIONS*

J. WARREN SMITH.

Evaporation depends in general upon thé dryness of the air, the velocity of the wind, and the temperature of the evaporating water. It makes no appreciable difference whether the evaporating surface is in the sunshine or in the shade.

The evaporation from a saturated soil covered with growing plants is greater than from a water surface, but becomes less when the level of complete saturation falls below the surface of the ground. It has been calculated that when the water table is six inches below the surface of the land the evaporation is 95% of what it is from an open tank.

Evaporation is greater from a forest of evergreen trees than one of leafy trees; greater from leafy trees than from grass, and greater from grass than a bare soil.

Newell states that the runoff over any watershed is from 36% to 47% of the rainfall, and the balance is evaporation, including in that of course transpiration of plants. Over the Muskingum watershed the average annual rainfall is 39.7 inches while the runoff is 13.1 inches.

Formulas for the annual evaporation over a watershed have been worked out as follows:

$E = 15.50 + 0.16 \times$ annual rainfall. (1)

or if thought best to consider the temperature,

$E = 15.50 + (0.16 \times R) \times (0.05 \times T - 1.48)$ (2)

R.=mean annual rainfall; T=mean annual temperature.

*Read at the meeting of the Ohio Academy of Science.

The amount of evaporation from a water surface is obtained by two methods:

(1) By direct measurements from properly exposed water surfaces.

(2) By computation based upon the temperature of the water surface and the value of certain meteorological elements.

The record of evaporation from exposed water surfaces is being very carefully made at the Columbus Reservoir and at the Cincinnati Water Works Reservoir in Ohio, and in other places thruout the country.

A table is attached giving the actual evaporation in inches from floating tanks in reservoirs at Boston, Mass., Rochester, N. Y., Menasha, Wis., Grand River, Wis., Iowa City, Ia., Madison, Wis., and Columbus, Ohio, in 1906.

EVAPORATION FROM A FLOATING TANK IN INCHES, YEAR 1906.

Stations	May	June	July	Aug.	Sept.	Oct.
Chestnut Hill Reservoir, Boston, Mass....	3.82	5.34	6.21	5.97	4.86	3.47
Mount Hope Reservoir, Rochester, N. Y......	3.78	5.05	5.47	4.96	4.07	2.92
Menasha, Wis	1.85	2.83	3.63	3.70	2.20	1.37
Grand River, Wis......	3.19	2.74	4.17	3.65	3.24	1.77
Madison, Wis..........	....	....	....	2.52	2.04	1.85
Iowa City, Ia..........	....	....	.....	4.93	3.76	2.21
Storage Reservoir at Columbus, O.........	....	....	5.44	5.42	5.59	6.36

In the second method of determining the evaporation over large reservoirs and lakes the principles of the Dalton formula have been adopted. This referred to the metric system is $E = C(e_w - e_d) + C(e_w - e_d)\ A\ w$.

In this E = the amount of evaporation in the unit of time,

C = a constant of evaporation,

e_w = the vapor pressure of the water temperature,

e_d = the vapor pressure of the dew point temperature,

A = a constant for the wind effect,

w = the wind velocity in kilometers per hour.

The constants will be changed for different units of time.

In some investigations made at the Chestnut Hill Reservoir, near Boston in 1876 to 1887, Fitzgerald developed the following formulas to determine the evaporation from easily made observations.

Evaporation in inches per hour:

$$E = \frac{(e_w - e_d) \times (1 + \frac{W}{2})}{60} \quad \text{or}$$

$$E = 0.0166\ (e_w - e_d) \times (1 + \frac{W}{2}).$$

e_w and e_d have the same value as in the Dalton formula above, and W represents the wind velocity in miles per hour.

His formula showing the evaporation in inches per day is

$$E = 0.3984\ (e_w - e_d) \times (1 + 0.0208\ w_1).$$

In this W represents the wind movement in miles for the day.

After the break in the Colorado River had been closed and it was known that the great Salton Sea in southern California must be reduced by evaporation in ten or twelve years, it was determined to take the opportunity to study evaporation on a large scale in the arid regions.

The importance of determining what the real evaporation is from irrigation and water supply reservoirs, especially in the arid region, can hardly be overestimated. In some instances reservoirs built at a large expense are nearly or quite dry during most of the year.

It has been estimated that the evaporation in southern Arizona is about 6 feet per year. If this is true the loss of water from evaporation from a reservoir like the Roosevelt Reservoir covering 16,320 acres would be sufficient to irrigate 48,960 acres of land.

The true evaporation is not known however, therefore after a Board of Conference had visited the Salton Sea region, the work of investigation was placed in the care of the U. S. Weather Bureau, and Professor Frank H. Bigelow was put in charge of it.

Professor Bigelow found that when the results were brought together from the different formulas that have been in use the constants do not agree. He thought it wise then to determine the cause for the discrepancy and to ascertain a correct formula if possible.

Consequently, he established five towers 40 feet in height in and about the Reno, Nevada, reservoir. On these towers evaporating pans were located at different altitudes, and pans were located at different points in the reservoir. Twenty-nine pans were distributed in this way and observations were made every three hours during August 1 to September 15, 1907.

From these investigations Professor Bigelow determined that a vapor blanket always overlays any body of evaporating water, and that pans were found to evaporate at very different rates according to their location. In fact the rate of evaporation seems to be controlled largely by the action of this invisible vapor covering water surfaces, irrigated fields, etc.

At Reno this vapor blanket seemed to have a depth of 40 feet over the city reservoir, but it will vary with the size of the sheet of water and the climate in which it is located. He states that in dry climates it will overspread the water laterally from 300 feet to one-fourth mile, according to the size of the sheet of water. In a moist climate it will be deeper and more extensive.

He has determined the value of the wind velocity constant and has developed the value of the water vapor in different parts of the reservoir. He calls this vapor value the "diffusion coefficient" and it, in connection with the height above the water and distance from the edge of the reservoir, suggests a logarithmic or geometrical law for the diffusion.

In the arid regions of the West it seems probable that this vapor blanket conserves about three-eighths of the water that would otherwise be lost by evaporation. He states that this rule may not hold true in other climates and that other observations should be made elsewhere.

He has determined that if the water evaporated between 7:30 A. M. and 10:30 A. M. at Reno during the summer time be multiplied by 8 it will closely represent the evaporation for the 24 hours of the day.

Professor Bigelow has suggested the following formula for trial instead of those based on Dalton's law, because it has worked well in the Reno investigations.

A full discussion of the Reno observations is made in the Monthly Weather Review for February, 1908.

Bigelow's Formula for Evaporation per Hour.

$$E = Cf(h)e_d \frac{de}{dS}(1 + Aw)$$

Cf (h) is a variable function of the evaporation, changing with the height above the water surface and the distance from the center in a horizontal direction. It includes the diffusion and mixing process. It has been worked out at Reno in centimeters, and the values will be given upon application to the Washington office of the Bureau.

$\frac{de}{dS}$ is the rate of change of the vapor pressure with the change of the temperature of the water at the surface. It represents the Clayperon formula for the volume of vapor derived from the unit volume of water at the temperature S. It can be found from Table 43, Smithsonian Meteorological Tables, 1907. A table of these values from 0 to 29° C. has been worked out and can be obtained in a pamphlet of instructions for evaporation observations issued by the Bureau.

e_d is the vapor pressure at the dew point temperature of the air. A is the wind effect constant, 0.0175. w is the wind velocity in kilometers per hour as read from the metric anemometer.

ANNUAL REPORT ON THE PLANTS NEW TO THE OHIO STATE LIST FOR 1907–8.

Freda Detmers.

The following plants have been added to the State Herbarium during 1907–8. Some of these have been previously reported as occurring in the state; a few have previously been placed in the herbarium, and the specimens added are from new localities and thus the range has been extended. The locality where the plants were collected, the original collector and the date of collection are given.

Cortinarius collinitus Fr. Chillicothe, Ross Co., Miss Mace, Oct., 1908. Reported in Mushrooms, edible and otherwise. M. E. Hard, from Salem, Bowling Green and Chillicothe, O.

Secotium acuminatus Montague. Pasture, Ohio State University farm, Freda Detmers, Oct. 13, 1908. Reported in Mushrooms, edible and otherwise. M. E. Hard, as quite abundant about Chillicothe; but so far as I know these specimens are the first to be collected at Columbus, and the first to be placed in the State Herbarium.

41. **Asplenium montanum** Willd. Clear Creek, Hocking Co., Earl Hyde, Aug. 1, 1908. This rather rare fern has heretofore been collected in two other localities: Cuyahoga, Summit Co., L. B. Tuckerman; Sugar Grove, Fairfield Co., R. F. Griggs, Mar. 22, 1907.

23. **Dryopteris cristata clintoniana** (Eat.) Underw. Wayne Co., L. S. Hopkins, June 30, 1904.

29. **Dryopteris boottii** (Tuck.) Underw. Middlefield, Geauga Co., L. S. Hopkins, June 15, 1905.

60a. **Lycopodium porophilum** Lloyd & Underw. Phalanx, Portage Co., Almon N. Rood, Sep. 18, 1908. This plant has thus far been collected at Sugar Grove, Fairfield Co., only, and thus Portage Co. is not only a new locality but also a northward extension of the range.

106. **Naias gracillima** (A. Br.) Morong. Doner's Lake, Wayne Co., A. D. Selby, July 21, 1899. The specimen is from the Ohio Experiment Station Herbarium.

265b. **Bromus unioloides** (Willd.) H. B. K. Station Farm, Wooster, Wayne Co., J. W. T. Duvel, June 6, 1898. The specimen is from the Ohio Experiment Station Herbarium.

283a. **Cyperus esculentus angustispicatus** Britt. Near Creston, Wayne Co., B. H. Thorne, Aug. 16, 1897. The specimen is from the Ohio Experiment Station Herbarium.

285a. **Cyperus engelmanni** Steud. Brown's Lake, Wayne Co., J. W. T. Duvel, Sept. 7, 1899. Reported by A. D. Selby at the Winter meeting of the Ohio Academy of Science, 1899.

286a. **Cyperus strigosus compositus** (L.) Britt. Wooster, Wayne Co., J. W. T Duvel, Aug. 4, 1899. The specimen is from the Ohio Experiment Station Herbarium.

343a. **Carex lurida flaccida** Bailey. Wooster, Wayne Co., J. W. T. Duvel, July 15, 1898. From the Ohio Experiment Station Herbarium.

369a. **Carex caroliniana** Schw. Station Farm, Wooster, Wayne Co., J. W. T. Duvel, June 17, 1898. From the Ohio Experiment Station Herbarium.

488a. **Juncus greenei** Oakes & Tuckerm. Wooster, Wayne Co., J. W. T. Duvel, Aug., 1895. From the Experiment Station Herbarium.

584a. **Gyrostachys praecox** (Walt.) Kuntze. Brown's Lake, Wayne Co., J. W. T. Duvel, Sept. 7, 1899. Reported by A. D. Selby at the Winter meeting of the Ohio Academy of Science, 1899.

1269. **Viola lanceolata** L. Sugar Grove, Fairfield Co., May Eva Lied, May 16, 1908. The plant was previously sent in by Otto Hacker, from Lake Co., in 1901. This second locality is therefore a southern extension of the range. It has been reported from Painesville, Lake Co., in Beardslee's catalogue and from Lorain Co., in A. A. Wright's catalogue.

1659. **Utricularia minor** L. Cranberry Is., Licking Co., Freda Detmers, Oct. 12, 1907. Reported in the Fourth State Catalogue, for northern Ohio, J. S. Newberry (cat.); for Licking Co., H. L. Jones (cat.); for Cincinnati, Thos. G. Lea (cat.).

1844a. **Solidago moseleyi** Fernald. Oxford Prairie, Erie Co., E. L. Moseley, Sept. No specimen of this plant is as yet in the State Herbarium, but it is reported in the 7th Ed. of Gray's New Manual of Botany, 1908.

1853a. **Aster roscidus** Burgess. Neapolis, Lucas Co., A. D. Selby, July 22, 1900. Reported in a paper, Notes on Plants for 1900 by A. D. Selby, read before the Academy of Science at the Winter meeting, 1900.

584b. **Gyrostachys simplex** (Gr.) Ktz. Walter Fischer, Sugar Grove, Fairfield Co., Sept. 23, 1905; Jesse E. Hyde, near Christmas Rock on sandy hilltops, Lancaster, Aug. 28, 1905.

THE OHIO SPECIES OF THE GENUS DISONYCHA.*

LEONARD L. SCOTT.

The genus Disonycha is a small group of beetles belonging to the family Chrysomelidae. They are generally distributed throughout the United States but are abundant only in certain sections, where they may become of some considerable economic importance. Certain species are distinctly southern in distribution, others are found more commonly in the arid portions of the country, while still other species may be found only in sections that are under cultivation. The species seem to possess, to quite a marked degree, the ability to adapt themselves to widely varying environmental conditions and this fact may be responsible for their very general distribution throughout the country. The food plants of the group as a whole are mostly herbaceous although some species may be found feeding on shrubs or even on forest trees. Several species are frequently reported as doing a very considerable amount of injury to the leaves of sugar beets and spinach, the latter becoming so badly eaten as to be unsalable. Lambs-quarter and spiny pigweed are also favorite food plants, but since these plants are not of economic importance, the injury done to them is beneficial rather than injurious. Two species reported from New York were found quite generally on the common arrow-head, Sagitarria variabilis and also on beets, spinach, Chenapodium album and Amarantus spinosus.

Some peculiar habits of the group are worth mentioning. In the first place in several of the species upon which observations have been made, the adults and larvae feign death and fall to the ground when suddenly disturbed, although if the approach is made quietly, the adults will either not move or will take wing and fly to another plant. On account of this habit, the cause of the injury to beet-leaves and the like is frequently not observed and may be attributed to other insects. D. quinquevittata has been observed (Ref's. 3, 7) swarming near Yuma, Arizona. About three o'clock in the afternoon an immense swarm, probably 20 or 25 feet thick, was observed passing up the Colorado River, following quite closely the bed of the stream and flying about 50 ft. above the water. When insects migrate, it is usually on account of a lack of food, but since there was an abundance of food present in this instance the migration may have been caused by the peculiarly sultry condition of the atmosphere at this time; this is frequently a cause of migration in other groups of insects. Reports of migrations of this species are not known from any other section of the country.

Although the group has been known for a long time and more or less work of a general nature has been done upon the various

* Read at the meeting of the Ohio Academy of Science.

species, in only one or two instances has anything like a definite life history been worked out and then not very completely. Reports of their occurrence, the extent of injury and occasionally a description of egg, larva or pupa, with a few recommendations for treatment make up the bulk of the limited amount of literature available. Mr. F. H. Chittenden[1] of the Bureau of Entomology has worked out the life history of Disonycha xanthomelaena at Washington, D. C. Miss M. E. Murtfeldt[5] reported the same species as doing considerable damage to spinach beds in Missouri in 1899. Mr. L. Bruner[6] has reported D. quinquevittata and D. pensylvanica as injurious to young trees in Nebraska, early in the spring when the buds begin to open. Mr. H. Garman[7] has reported D. glabrata from Lexington, Ky. where the larvae strip the leaves from pigweed, Amarantus retroflexus.

D. triangularis and D. xanthomelaena also do a considerable amount of injury to beet leaves in Illinois, although the natural host plant is the lambs-quarter. Brief mention of some of the other species has been made at various times, a list of which literature is found in the appended bibliography.

Of the 18 species in the genus, 11 are found in Ohio, the list of which is as follows:

1.	Disonycha	pensylvanica.	7.	Disonycha	abbreviata.
2.	"	discoidea.	8.	"	triangularis.
3.	"	quinquevittata.	9.	"	xanthomelaena. (collaris.)
4.	"	crenicollis.			
5.	"	caroliniana.	10.	"	mellicollis.
6.	"	glabrata.	11.	"	collata.

A complete key and quite elaborate descriptions of all the 18 species of the genus has been worked out by Mr. Geo. H. Horn, M. D., and included in his paper on "A Synopsis of the Halticini of Boreal America" and since no key for the distinctly Ohio species is in print, the following key, adapted in great part from Horn, is presented with brief descriptions and notes on the distribution of the several Ohio species.

Key to the Ohio Species of Disonycha.

After Geo. H. Horn, M. D.

1. Form elongate, parallel, elytra subsulcate, thorax rather irregularly convex; elytra yellow, with black vittae. ....**pensylvanica.**

   Varieties:

   Thorax with spots confluent in a large discal black space, having a comparatively narrow yellow border. Body beneath and legs black .... **limbicollis.**

   Head in part yellow. Thorax beneath entirely yellow. Body beneath black, abdomen paler at sides and apex...**pensylvanica**

   Head in part yellow. Thorax beneath entirely yellow. Body beneath black. Abdomen paler at sides and apex. Legs are reddish yellow, tibia darker, tarsi piceous.... ...**pallipes.**

   Black of the surface replaced by a rufous; legs even to tarsi, reddish yellow .... **conjugata.**

   Form more or less oval, elytra even; thorax regularly convex......2

2. Elytra vittate 3
   Elytra with large discal spot black ....**discoidea.**
   Elytra dark violet, olive or green 8
3. Elytra with a submarginal vitta 4
   Elytra without submarginal vitta 7
4. Abdomen densely punctured, subopaque, the pubescence conspicuous 5
   Abdomen very sparsely punctured and shining.
   Pubescence scarcely visible 6
5. Head coarsely punctured from side to side; occiput piceous or brown. **quinquevittata.**
   Head smooth at middle.
   Elytral vittae rather broad, head and metasternum more or less fuscous or piceous, labrum piceous ....**crenicollis.**
   Elytral vittae narrow, head and body beneath always pale yellow, labrum pale ....**caroliniana.**
6. Thorax smooth; head rough; epipleurae black ....**glabrata.**
7. Median elytral vitta broad; antennae normal; thorax not spotted... **abbreviata.**
8. Body beneath and legs entirely black; thorax with three spots in a triangle; elytra punctate ....**triangularis.**
9. Posterior femora entirely or in part piceous..
   Abdomen alone entirely yellow; hind femora bicolored or entirely black; head piceous; elytra blue-black ....**xanthomelaena.**
   Posterior femora entirely yellow; abdomen piceous, apex and sides yellow; head bicolored. Elyrta blue or violet; form of body oval, as in xanthomelaena ....**mellicollis.**
   Elytra bright green, form more oblong ....**collata.**

D. pensylvanica. Illig. Oblong, nearly parallel. Head black, front yellow, surface nearly smooth except a small group of punctures near each eye. Scuttelum black. Body beneath entirely black, side margin of elytra and outer side of epiplurae yellow, the inner margin usually piceous. Abdomen finely pubescent; legs variable in color from black to rufous.

This species occurs all over the United States and Canada, but is more especially the species of the northern region, that is to say, it extends east and west, north of the fortieth parallel of latitude. In Ohio this species has been taken at Sandusky, Columbus, and Cincinnati and probably occurs elsewhere in the state.

D. discoidea. Fab. Oval, slightly depressed. Head yellow, surface smooth, a small fovea at the upper inner border of the eye. Scutellum yellow. Body beneath, entirely yellow. Abdomen punctate, pubescence distinct, but not conspicuous. Legs yellow, the outer side of the tibia and the tarsi black. Length .22–.30 inch; 5.5–7.5 mm.

This species varies but little and occurs generally from North Carolina to Texas. The species has been taken from Hanging Rock and Cincinnati in southern Ohio.

D. quinquevittata. Say. Oblong oval. Head yellow and except in rare instances with the occiput piceous; coarse and deep punctures extending from side to side of vertex. Thorax with 5 black spots, often only two present. Scutellum black. Epiplurae pale; body beneath reddish yellow. Abdomen densely punctured, pubescence close and conspicuous. Legs reddish yellow, tibia at tip darker, tarsi piceous. Length 5.5–9. mm.

This species is especially that of the entire region west of the Mississippi River, extending from our northern boundary to

Mexico and from the Mississippi to the Pacific. It occurs sparingly farther east. The species is quite numerous at Sandusky, Ohio, and has also been taken at Georgesville and Cincinnati.

D. crenicollis. Say. Oval, slightly narrower in front. Head either entirely yellow or with occiput piceous. Scutellum black. Prothorax beneath yellow. Metasternum black, abdomen yellowish or pale brown, densely punctured and with a conspicuous silken pubescence. Femora reddish yellow, piceous along the upper edge, tibia and tarsi piceous. Length 5.5–6.5 mm.

This species occurs from New York to southwestern Texas and Mexico and has been taken in Ohio at Cincinnati.

D. caroliniana. Fab. Oval, slightly narrower in front. Head entirely yellow, entirely smooth except a punctured fovea at the upper inner border of the eye. Thorax with two piceous spots of variable size behind the apical border. Scutellum black. Body beneath reddish yellow. Epiplurae entirely piceous, sometimes entirely yellow. Abdomen closely punctate, pubescence distinct. Legs reddish yellow, tibia at tip and tarsi piceous. Length 5.–6 5 mm

This species occurs from Pennsylvania to Florida and has been taken at Columbus, Ohio.

D. glabrata. Fab. Oblong oval, surface very shiny, as if varnished. Head variable in color, often entirely black or entirely yellow Thorax yellow with a narrow median spot, often indistinct Scutellum black. Body beneath yellow, posterior portion of metasternum rarely piceous. Abdomen finely alutaceous, sparsely punctate. Legs yellow, tips of tibia and tarsi piceous. Length 5 –5 5 mm

Occurs from Georgia to Arizona and has been reported from Columbus and Cincinnati, Ohio.

D. abbreviata. Mels. Oval, slightly oblong. Head yellow, surface smooth, a rounded punctured fovea at the upper and inner border of the eye. Scutellum yellow. Body beneath and epiplurae yellow. Abdomen sparsely punctate, shining, pubescence short. Legs yellow, the outer side of the tibia and tarsi black. Length 6.–8 5 mm

Occurs from the Middle States to Florida and Texas, extending into Mexico. Also reported from Columbus and Cincinnati, O.

D. triangularis. Say. Form oval, rather depressed, feebly shining. Entirely black, thorax reddish yellow with three black spots arranged in a triangle. Head entirely black. Prothorax beneath yellow. Abdomen coarsely punctate, pubescence short and indistinct. Legs entirely black. Length 5.–6.5 mm.

Occurs in the entire region east of the Rocky Mountains, including Canada. Reported in Ohio from Columbus and Cincinnati.

D. xanthomelaena. Dalm. Oval, slightly depressed, feebly shining, thorax yellow, elytra dark blue. Head black with a few coarse and deep punctures, irregularly placed. Prothorax beneath yellow, metasternum black. Abdomen entirely yellow, densely punctate with distinct pubescence. Femora yellow at basal half, (sometimes entirely black) the apical piceous, also the tibia and tarsi. Length 5.5 mm.

Occurs from the New England States to Kansas, Texas and Florida. Reported in Ohio from Columbus and Cincinnati.

D. mellicollis. Say. Oval, similar in form to xanthomelaena Head blue-black between the eyes and posteriorly, front yellow, a few deep coarse punctures near each eye Thorax pale yellow Prothorax yellow beneath, metathorax piceous, abdomen piceous at the middle with apical segment and wide border yellowish Femora entirely yellow; tibia piceous, paler at the base, tarsi piceous Length 4 5–5 mm.

Occurs in Louisiana, Texas and Colorado. Also reported from Cincinnati, Ohio.

D. collata. Fab Oval, slightly oblong, sub-depressed Vertex and occiput black, front yellow, a few coarse punctures close to the eyes. Thorax yellow, immaculate Prothorax beneath yellow, metasternum black. Abdomen piceous with the last segment and sides broadly yellowish, densely punctured with a distinct pubescence Femora pale yellow, tibia at tips and tarsi piceous. Length 4 –4 5 mm

Occurs in Georgia and Florida. Reported from Cincinnati, O.

LIFE HISTORY STUDIES.

While at the Ohio State University Lake Laboratory at Sandusky the past summer, opportunity was afforded to do some work on the life history of D. quinquevittata, the life cycle of which species, as far as I am aware has never been studied

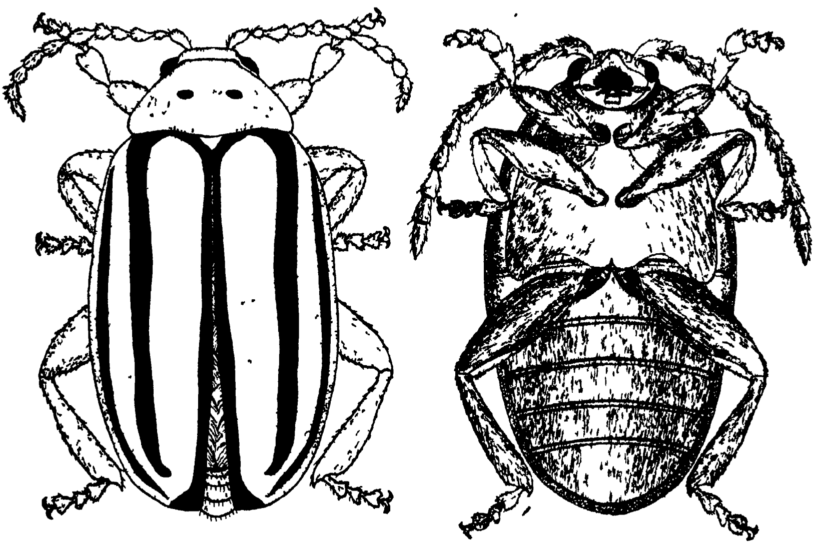

Fig. 1. Disonycha quinquevittata. Dorsal and ventral view of adultbeetle.

The beetles and larvae in this region feed upon a small scrub willow, Salix interior, which grows in rather isolated and well defined patches on the sand plain on the lake side of Cedar Point, and when I arrived at the Laboratory about the 25th of June, the beetles were quite abundant, and some larvae were found although not as many as later on.

About the middle of July the larvae became very numerous and the adult beetles decreased very appreciably in number. By the first of August the larvae had practically all disappeared and the adults were quite numerous again, and as further observations until the first of September failed to show another brood of larvae, it is probable that the species is single-brooded in this locality, and that the beetles hibernate through the winter and with the warming of the ground in spring they appear and lay the eggs for the production of the generation of larvae which was beginning to appear when I arrived.

Fig. 2. Beetle on Salix interior showing extent of injury.

The adult beetles are oblong, oval and vary from 8—10 mm. in length and from 4- 6 mm. in width. The eggs are elliptical, of a bright yellow color and have a finely reticulated surface; they average .59 mm in diameter and 1.74 mm. in length and are deposited rather promiscuously on the sand under the host plant, according to observations made in the insectary. This method of egg deposition would seem to agree fairly well with that of Disonycha xanthomelaena, yet whether or not this method would prevail in nature cannot be said with certainty.

The eggs require from six to seven days to hatch, the young larvae escaping by a longitudinal slit near the end of the egg as in xanthomelaena. The larvae are voracious feeders and grow rapidly during this entire stage which lasts from twenty-eight to thirty days.

A Coleopterous pupa case was found buried about three inches in the sand under one of the willows and although the pupa was

dead, it was probably that of D. quinquevittata. It was an elliptical, capsule-like body, about ¼-inch long with the outside covered with fine grains of sand. The pupa stage probably lasts from six to nine days as in xanthomelaena.

Thus the development may be said to require from forty to forty-five days. The reason for the adults and larvae overlapping so much during the early part of the season may be attributed to the difference in the time of the appearance of the adults in the spring. The whole life cycle is probably an adaptation to the peculiar conditions of this locality and may very likely differ much from the normal cycle under ordinary conditions.

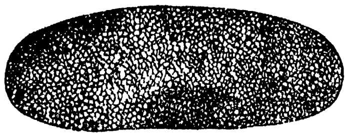

Fig. 3. Egg of Disonycha quinquevittata.

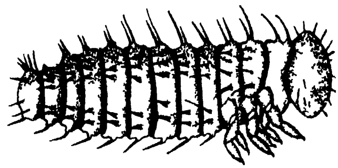

Fig. 4. Newly hatched larva of Disonycha quinquevittata.

Another species, Disonycha pensylvanica, variety pallipes also occurs in this region, although not as abundant as the preceding form. The beetles are somewhat smaller than D. quinquevittata, not so oval and have sub-sulcate elytra and a parallel form. The black elytral vittae are also much wider, giving the insect a much darker general appearance.

The eggs are laid in small bunches on the surfaces of semi-erect leaves of Polygonum emersum. The young larvae at once begin feeding upon these leaves, which soon become perforated with small holes and turn brown.

When the larvae are full grown they crawl off this plant to neighboring stalks of the Burr Reed—Sparganium eurycarpum. Each larva bores into the thick lower part of a leaf or stalk of this plant and forming a little cell for itself, lies head uppermost and here pupates. The pupae are bright orange or salmon color. Each stalk of the second host plant may contain a dozen or more pupae lying end to end in separate cells.

The length of the various stages of this species were not determined, but it is probable that the life cycle occupies somewhere near the same period as D. quinquevittata, since both occur so close together.

The writer wishes to express his sincere thanks to those who have, in various ways, contributed to the success of this work. Among these, should be mentioned first, Professor Herbert Osborn, under whom the work was conducted and whose valuable suggestions have aided in no small way the character of

the results obtained. Professor J. S. Hine gave the use of his private collection and also offered many valuable suggestions. Miss M. M. Haskins, of Toledo, Ohio, continued the observations at the Lake Laboratory for some time after August 1st when the writer left. Thanks are also due Mr. R. J. Sim for the observations made upon Disonycha pensylvanica pallipes, which he kindly furnished, and which are included in the present treatise.

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VARIATION IN SYNDESMON AND HEPATICA.

ROSWELL H. JOHNSON.

Prof. Kellerman, in the OHIO NATURALIST for May, 1901, published an article on Variation in Syndesmon thalictroides (L) Hoffrug, based upon material from six Ohio localities, and at the time he called for additional notes from other places. I, therefore, venture to send to you the observations I have made upon this species in four other states compared with his, together with a similar study of Hepatica.

RUE ANEMONE, SYNDESMON THALICTROIDES.

From a study of the tables I–VII we may reach the following conclusions.

TABLE I—NUMBER OF FLOWERS PER STEM.

LOCALITY AND DATE.	N	1	2	3	4	5	6	7	8	9	10	Av.
Natick, Mass., May 6, '99	75			70	5							3.06
A Stony Brook,(RR) Mass., May 7,'99	83			53	25	5						3.41
B " " Mass., May 7,'99	13			13								3.00
E Yonkers, N. Y., Apr. 20, '99	46	0	0	31	15	0	0	0				3.32
A Yonkers, N. Y., Apr. 21, '99	38	0	1	28	9	0	0	0				3.21
Alpine, N. J., Apr. 23, '99	13	0	0	10	3	0	0	0				3.23
Toledo, Ohio	30	1	0	13	15	1						3.50
Steubenville, Ohio	17	0	0	7	8	2						3.70
W. Mansfield, Ohio	11	1	1	3	6	0						3.27
Rendville, Ohio	12	0	0	9	2	1						3.33
Columbus, Ohio	12	1	0	2	8	1						3.67
St. Marys, Ohio	18	0	0	16	2	0						3.11
A Riverside, Ill., May 12, '00	11	0	0	4	7	0	0	0				3.64
B Riverside, Ill., May 12, '00	66	0	0	43	20	1	0	1	0	0	1	3.49
Glencoe, Ill., May 5, '00	65	0	0	52	12	1	0	0				3.20
A Madison, Wis., May 2, '02	93	8	7	59	14	5	0	0				3.00
A " " May 12, '02	110	40	19	38	12	1	0	0				2.23
B " " May 25, '02	41	11	6	13	7	4	0	0				2.67
B " " June 10, '02	7	1	4	1	1	0	0	0				2.27
C " " May 25, '02	74	4	6	25	29	8	1	1				3.51
C " " June 10, '02	73	6	6	22	28	8	3	0				3.45
Total	908	73	50	512	228	38	4	2	0	0	1	3.15

1. The typical number of flowers is three—a terminal one and two lateral ones each in the axil of one of the involucrate leaves. One of these lateral flowers may be missing, but in case of reduction, both are more likely to disappear. Additional flowers may appear, generally as additional axillary flowers to the involucre, but in some cases, especially where there are many, in the axils of additional leaves above or below the involucre.

2. All the characteristics studied vary from place to place as determined, but since it also varies greatly from one grove to another in the same vicinity and from time to time, the amount of the variation which is truly geographical is difficult to determine.

TABLE II. NUMBER OF INVOLUCRATE LEAFLETS.

LOCALITY AND DATE	N	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Av.	% petiolate leaves
Natick, Mass., May 6, 99	75		2	1	2	65	5										5.92	
A Stony Brook, Mass., May 7, '99	83				1	52	15	8	4	1	2						6.65	
B " " May 7, '99	13			1		12											5 84	
C Yonkers, N. Y., Apr. 19, '99	21					15	5	1									6 33	
E " " Apr. 20, '99	46					31	2	0	13								6 88	
A " " Apr. 21, '99	39				2	27	6	1	3								6 37	
Alpine, N. J., Apr. 23, '99	14					10	4										6 28	
Toledo, Ohio	30	2	1	4	1	8	10	0	3	1							6 09	90
St. Marys, Ohio	18	4	0	5	0	7	1	0	1								4.77	78
Steubenville, Ohio	17					7	6	2	1	1							7 00	0
W. Mansfield, Ohio	11	2	0	1	0	2	5	0	1								5 82	64
Rendville, Ohio	12					9	0	0	2	0	0	1					7.00	67
Columbus, Ohio	12	1	0	1	0	1	5	0	3	1							7.00	58
Glencoe, Ill., May 5, '00	65			8	1	44	9	1	2								5.97	
A Riverside, Ill., May 12, '00	11					4	6	1									6.73	
B " " May 12, '00	77	1	0	5	1	49	17	1	3								6.13	
A Madison, Wis., May 2, '02	103				21	66	14	2									5.97	7
A " " May 12, '02	110				2	93	12	1	1	1							6.17	32
B " " May 25, '02	41			1	0	28	6	4	1	1							6.44	24
B " " June 10, '02	7					5	1	1									6.39	43
C " " May 25, '02	74			1	0	32	23	8	4	5	0	0	0	1			7.03	17
C " " June 10, '02	74					25	27	5	7	6	1	2	0	0	0	1	7.47	16
Total	953	10	3	28	31	592	179	36	49	17	3	3	0	1	0	1	6.40	41.33

In the case of the Ohio localities it was necessary to count a leaf as three leaflets. This introduces a slight error in those cases as compared with the others.

3. The number of involucrate leaflets has maxima at 3, 6, 9, and 12, because of the trifoliate leaves. The maximum at 6 is by far the most frequent, corresponding to three flowers.

TABLE III. NUMBER OF SEPALS ON TERMINAL FLOWERS.

LOCALITY AND DATE	N	4	5	6	7	8	9	10	11	12	Av.
Natick, Mass., May 6, '99	74		1	15	51	5	2				6.89
A Stony Brook, Mass., May 7, '99	67			13	31	16	7		·		7.24
B Stony Brook, Mass., May 7, '99	13			2	11						6.84
A Yonkers, N. Y., Apr. 17, '99	14			5	4	3	1	0	0	1	7.35
A " " Apr. 21, '99	37			7	24	4	2				7.02
C " " Apr. 19, '99	27			1	5	18	3				7.84
E " " Apr. 20, '99	49			1	16	17	10	4	1		8.06
Alpine, N. J., Apr. 23, '99	14			2	10	2					7.00
Glencoe, Ill., May 5, '00	64	1	3	38	20	2					6.29
A Riverside, Ill., May 12, '00	2				1	1					7.50
B " " May 12, '00	38		5	12	12	9					6.65
A Madison, Wis., May 2, '02	89		7	48	25	6	3				6.42
A " " May 12, '02	67		6	40	18	2	1				6.27
B " " May 25, '02	26	1	3	12	6	4					6.34
B " " June 10, '02	2			1	1						6.50
C " " May 25, '02	15			4	6	5					7.06
C " " June 10, '02	3		2		1						5.66
Total	601	2	27	201	242	94	29	4	1	1	6.85
Total all flowers	1241	30	256	520	298	100	29	6	1	1	6.24

TABLE IV. NUMBER OF SEPALS ON LATERAL FLOWERS.

LOCALITY AND DATE	n	4	5	6	7	8	9	10	Av.
Natick, Mass., May 6, '99	18		4	14					5.77
A Stony Brook, Mass., May 7, '99	159		68	70	21				5.70
E Yonkers, N. Y., Apr. 20, '99	3				3				7.00
Glencoe, Ill., May 5, '00	24		7	16	1				5.74
A Riverside, Ill., May 12, '00	13	1	8	4					5.23
B " " May 12, '00	48	4	27	17					5.26
A Madison, Wis., May 2, '02	125		21	80	21	2	0	1	6.06
A " " May 12, 02	71	1	25	42	3				5.63
B " " May 25, '02	38	5	14	16	3				5.44
B " " June 10, '02	4		2	0	1	1			6.25
C " " May 25, '02	82	7	34	40	1				5.38
C " " June 10, '02	55	10	19	20	2	3	0	1	5.48
Total	640	28	229	319	56	6	0	2	5.67

TABLE V. NUMBER OF CARPELS ON TERMINAL FLOWERS.

Locality and Date	N	0	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Av.
Natick, Mass., May 6, '99	71			4	8	13	15	7	12	3	5	2	1	1																	7.55
A Stony Brook, Mass., May 7, '99	83			2	5	8	8	9	12	11	9	6	9	1	2	1															9.30
B Stony Brook, Mass., May 7, '99	13						1	0	4	3	1	2	1	0	0	1															10.54
C Yonkers, N. Y., Apr. 19, '99	22					2	1	2	2	1	5	6	1	0	2																10.58
E Yonkers, N. Y., Apr. 20, '99	42				1	1	3	3	3	5	2	9	4	5	4	2															11.35
A Yonkers, N. Y., Apr. 21, '99	28					4	6	4	6	1	3	2	0	2																	8.82
Alpine, N. J., Apr. 23, '99	14				1	1	4	0	5	2	0	0	1																		8.28
Glencoe, Ill., May 5, '00	65			1	1	3	4	6	6	7	6	8	4	4	3	4	2	3	1	1	1										11.54
A Riverside, Ill., May 12, '00	10							2	1	1	2	2	0	0	0	0	1	1													11.60
B " " May 12, '00	52		1	2	3	5	9	9	4	7	3	0	2	4	2	0	1														8.81
A Madison, Wis., May 2, '02	82					3	2	5	11	16	9	3	7	4	5	2	7	2	0	2	0	2	1	1							12.27
A " " May 12, '02	97	1			4	8	5	15	11	6	14	6	3	7	2	2	2	4	6	1											10.79
B " " May 25, '02	28					4	2	0	3	4	1	2	2	1	2	1	0	1	0	0	1	1	0	1	0	0	0	1	0	1	13.17
B " " June 10, '02	2												1				1														15.00
C " " May 25, '02	22				1	1	0	1	1	1	2	1	0	0	1	2	3	2	1	2	0	0	1	0	0	1	1				15.48
C " " June 10, '02	7	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0	0	0	1									11.64
Total	638	2	1	9	24	53	60	64	81	69	62	50	36	30	23	16	17	13	8	6	2	4	2	2	0	1	1	1	0	1	10.55
Total all flowers	1220	6	2	16	45	110	133	149	156	123	108	96	69	66	34	32	25	16	10	8	3	4	2	3	0	1	1	1	0	1	10.11

TABLE VI. NUMBER OF CARPELS ON LATERAL FLOWERS.

Locality and Date	N	0	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Av.
Natick, Mass., May 6, '99	18				2	6	5	1	2	1	1														7 10
A Stony Brook, Mass., May 7, '99	161	2	1	3	10	24	29	35	26	16	10	3	2												7.81
E Yonkers, N. Y., Apr. 20, '99	3									1			1	1											12 32
Glencoe, Ill., May 5, '00	25						2	5	3	5	1	3	2	2	1	1									10.52
A Riverside, Ill., May 12, '00	24			1	2	0	6	7	1	5	0	1	1										2		8.15
B " " May 12, '00	45			1	3	10	11	10	6	4															7.33
A Madison, Wis., May 2, '02	85					6	5	9	14	9	9	10	5	13	0	5									10.59
A " " May 12, '02	47			1	2	5	10	6	4	4	4	4	4	1	1	1									9.05
B " " May 25, '02	29			1	0	0	1	3	2	0	2	5	3	6	2	1	2	1							12.25
B " " June 10, '02	6										1	1	2	1	0	0	0	0	1						13.61
C " " May 25, '02	85	1	0	0	2	5	2	4	7	5	12	12	9	5	5	6	5	2	1	1	0	0	0	1	11.96
C " " June 10, '02	55	1	0	0	0	1	2	5	10	4	6	7	4	8	2	2	1	0	0	1	1				11.29
Total	583	4	1	7	21	57	73	85	75	54	46	46	33	37	11	16	8	3	2	2	1	0	0	1	9 64

4. The number of sepals and carpals is greater on the terminal flowers than on the lateral ones.
5. The number of carpals and sepals is greater according as the number of flowers on the plant is greater.

TABLE VII. CORRELATION OF POSITION AND NUMBER OF FLOWERS WITH NUMBER OF SEPALS AND CARPELS IN THE LOT FROM A. MADISON, MAY 2, 1902.

No. of Flowers on Plant	No. of Sepals				No. of Carpels			
	n	terminal	n	lateral	n	terminal	n	lateral
2	4	6.0	4	5.5	2	9.5	2	10.0
3	31	6.3	64	5.8	19	13.0	38	10.2
4	11	7.1	33	6.2	10	16.2	30	12.6
5	3	7.7	12	6.25	2	16.5	8	15.2
All plants	49	6.5	111	6.0	33	14.0	78	11.7

6. There are probably changes in the number of the several parts through the season, but the data is too conflicting to permit generalizations as to the direction of these changes in each case.
7. These results agree with those of Shull on Aster that place modes of floral parts cannot be used for geographical comparison without the most careful discrimination as to the other causes which affect the number of parts.

HEPATICA.

A study of Table VIII leads to the following conclusions:

1. Hepatica acuta (Pursh) Britton has a larger and more variable number of sepals than Hepatica Hepatica (L.) Karst.
2. The proportion of the individuals having flowers of the several colors differs greatly from one general locality to another and even from grove to grove in one locality.
3. There is no consistent correlation of appreciable magnitude between the number of flowers or number of sepals and the color of sepals.
4. The number of sepals per flower is regularly greater where the number of flowers per plant is greater.
5. The number of sepals has a skew variation towards increased number of sepals in conformity with most floral variation.

TABLE VIII VARIATION OF HEPATICA

Species	Locality	Date	Class	n	Plants with less than 4 flowers	Plants with more than 4 flowers	Number of Sepals									Lobes of leaves		
							5	6	7	8	9	10	11	12	Ave	3	4	5
H Hepatica	A Yonkers N Y	Apr 17 99	blue	272	62	155	1	220	45	5	1				6 21			
"	"	"	pink	6	1	5	0	4	2	0	0				6 31			
"	"	"	white	16	7	9	0	8	7	1	0				6 56			
"	"		—4	58			0	53	5	0	0				6 07			
"	"	"	+4	77			1	59	14	1	2				6 23			
"	"	"	all	294			1	232	54	6	1				6 23	94	2	
"	C Yonkers, N Y	Apr 19 99	blue	28	6	17		20	7	0	1				6 35			
"	"		pink	112	44	50	2	97	12	1					6 10			
"	"		white	18	10	8		17	1						6 05			
"	"	"	—4	58				53	5						6 07			
"	"	"	+4	78			2	59	14	1	2				6 25			
"	"		all	158			2	134	20	1	1				6 14	126	1	
"	D Yonkers, N Y	Apr 20, 99	blue	52	35	10		47	5						6 09			
"	"		pink	39	13	6		35	2	2					6 14			
"	"		white	14	1	7		8	4	1	1				6 64			
"	"	2	—4	60				55	5						6 06			
"	"	"	+4	25				19	4	1	1				6 36			
"	"		all	105				90	11	3	1				6 19			
"	G Yonkers, N Y	Apr 20 99	blue	83	64	6	1	57	18	6	1				6 36			
"	"		pink	6	23	6		6	0	0	0				6 00			
"	"		white	37	6	0		26	9	1	1				6 37			
"	"	"	—4	92				69	19	3	1				6 26			
"	"		—4	12				1	8	2	0	1			7 33			
"	"	"	all	126			1	89	27	7	2				6 36	128	9	1
"	Winchester, Mass	Apr 23, 99	all	57				30	24	2	1				6 53			
H acuta	Glercoe Ill	May 5, 00	blue	30				5	8	5	4	2	2	4	8 39			
"	"	"	pink	20				5	6	1	5	1	2		7 85			
"	"	"	white	47				13	9	8	8	7	1	1	7 84			
"	"	"	all	[illegible]				23	23	14	17	10	5	5	8 02			
H Hepatica	all	several	all	7			4	575	136	19	6				6 25			

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THE SPOROPHYLLS OF LESSONIOPSIS.

ROBERT F. GRIGGS.

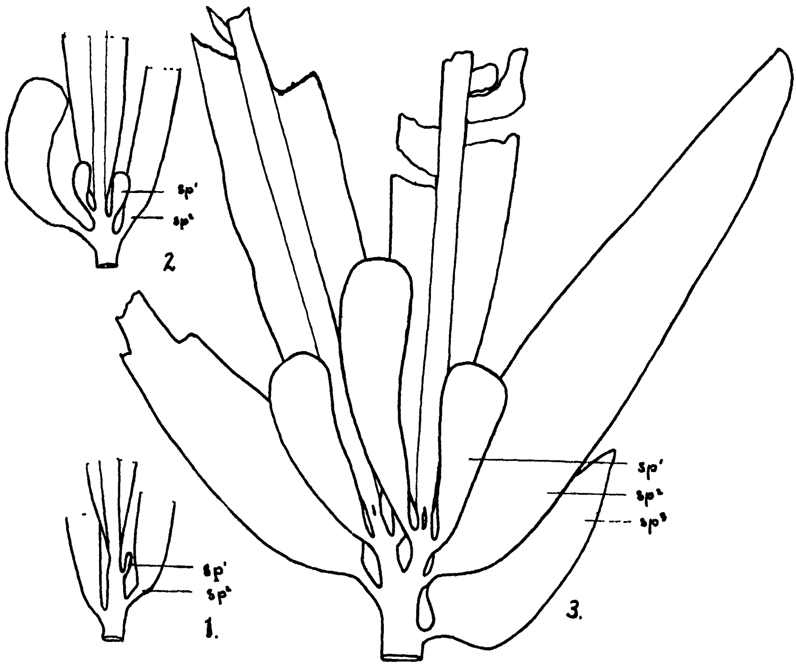
In a former paper on the development of Lessoniopsis litoralis (Griggs '09), the writer pointed out the fact that the division of the lamina by a basal perforation characteristic of the subfamily is always symmetrical involving the midrib and giving rise to two similar laminae each with a midrib in its centre. In such a process there is no place for the formation of sporophylls which lack the midrib. Since the former account was written material has come to my attention which shows the origin of sporophylls. This is a medium sized plant collected at the Minnesota Seaside Station early in July. Most of the sporophylls are already full grown but there are a number, especially on the smaller branches around the base of the plant, in all stages of development.

From branches with sporophylls of different ages it is at once apparent that they correspond with the sporophylls of such kelps as Alaria and Pterygophora. They are not cut off by splits in the transition region like the sterile laminae, but are outgrowths from the meristem below the base of the laminae. The youngest are mere knots roughening the edge of the stipe. These grow outward as in Pterygophora with scarcely any flattening till they reach about 1 cm. in length (fig. 1). But soon they begin to expand and each becomes a sessile spatulate blade (fig. 2). Under the protection of the surrounding laminae they reach about a decimeter in length (fig. 3) before the erosion of the waves begins to destroy the rounded tips. Up to this age

* Contributions from the Botanical Laboratory of Ohio State University, XXXIX.

they are usually falcate; widest at the extremity and cuneate at the base. After that length is reached they appear to grow more slowly and to broaden as well as lengthen till they are as long as ordinary laminae and have semicircular or subcordate bases (fig. 3).

The diverse modes of origin of the two kinds of laminae emphasizes the importance of the dimorphism of the laminae. This was the character which caused Reinke ('03) to separate this plant from Lessonia and erect for it the genus Lessoniopsis. It is apparent that this is as valid a genus as any of the kelps.



The origin of sporophylls in Lessoniopsis; about one-half natural size.

These proliferated sporophylls give Lessoniopsis a very great interest from a phylogenetic point of view, for in them this plant shows the characters of both of the principal lines of development in the kelps. In the Lessoniatae branching is accomplished exclusively by the perforation of the meristem as in the sterile branches of this genus. In the Alariatae it is brought about altogether by proliferations from the transition region; these give evidence that they were originally restricted to reproductive functions as in this plant and that their further development

into main branches, floats and photosynthetic areas as in Egregia, was accomplished by sterilization and modification of potential sporophylls. At first thought it might be supposed that Lessoniopsis, by the possession of the characters of both lines, should be regarded as representing a basal point from which both subfamilies had originated by following divergent lines of evolution. Such seems, however, an untenable view. There are none of the indications of a primitive character for Lessoniopsis. It is, in the judgment of the writer, clearly a member of the Lessoniatae. The characteristic branching of that series is the dominant character of Lessoniopsis and gives it the form and structure of its adult body, while the proliferated sporophylls do not make their appearance until the plant has practically completed its development. This is in great contrast to the Alariatae in which the sporophylls appear very early even in the lowest members where their function is almost exclusively reproductive and is not called into activity until maturity.

The unlooked for appearance of such a character among the Lessoniatae is to be considered as a striking example of the remarkable adaptability of the whole family of kelps by virtue of which we find in more than one plant structures belonging to lines otherwise entirely disconnected from it. This makes it difficult to construct a satisfactory classification of the genera because inconsistencies from this cause are almost unavoidable whatever principle of classification is used. The descent of the kelps seems to be a much interwoven fabric which has been surprisingly little divided up into narrower strands by the loss of plasticity by which each line is narrowed into its own special channel of evolution. This great variability along with many other features of the kelps leads to the view that the group is still in its youth and evolving rapidly.

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SOME NEW OR OTHERWISE NOTEWORTHY PLANTS FROM OHIO.*

OTTO E. JENNINGS.

During the latter part of March, 1907, the writer received from Mr. Roscoe J. Webb, a specimen of **Cerastium** in flower, collected near the top of the deep gorge of the Rocky River, about one-fourth mile from Lake Erie, June 23, 1907.

At first the plant, in the absence of mature fruit, was regarded as an **Alsine** and was laid aside in the hope that fruiting material might be secured the following season. However, this result was not realized and a further study of the specimen together with another from the same collection sent later by Mr. Webb has enabled us to decide definitely upon the taxonomic status of the plants. This opportunity is taken to present the results of our studies in the hope that other Ohio botanists may add further records to the distribution and more complete details to our description.

The plants in question belong to **Cerastium arvense** L., a species occurring in northern Eurasia and in dry or rocky places throughout the northern part of North America from Alaska to Labrador and south to Minnesota, Indiana, Michigan, Ohio, Pennsylvania, and in the mountains to Georgia. According to our manuals this is a perennial with ascending to erect stems usually tufted, glabrous to somewhat downy, slender, 1 to 2 cm. high, naked and few to several flowered at the summit. Leaves linear to narrowly lanceolate. Petals obcordate and more than twice as long as the calyx. Pods about 1 cm. long, curved, one-third to two-thirds longer than the calyx.

For the northern part of Northern America the typical species appears to be the common form of the plant but in the southern part of its geographical range it breaks up into several "varieties." Of these varieties there are two recognized in the northeastern United States and we must consider the Rocky River specimens as representing a third and hitherto undescribed "variety."

Cerastium arvense oblongifolium (Torr.) Hollick & Britton as represented in the Herbarium of the Carnegie Museum is taller than the typical species, reaching about 4 dm.; pubescent, usually somewhat viscid-pubescent; leaves oblong to lanceolate, rather obtuse, larger than in the species; pods about twice as long as the calyx. Chiefly on serpentine rocks, Nova Scotia to Virginia, New York to Minnesota, Colorado. In the Carnegie Museum Herbarium there is a specimen from Put-in-Bay, H. N. Mertz, No. 323, July 1, 1881.

* Presented at the meeting of the Ohio Academy of Science.

Cerastium arvense villosum Hollick & Britton. (**C. arv. velutinum** (Raf.) Britton. Similar to the preceding in height; densely villous-pubescent: leaves lanceolate to more or less ovate; pod usually more than twice as long as the calyx. Usually on serpentine rock, eastern Pennsylvania, also reported from Hamilton, Ontario; not reported from Ohio.

Cerastium arvense Webbii var. nov. Similar to the other "varieties" in height, our specimens about 3.5 to 4 dm., more or less densely viscid-pubescent, especially above. Leaves oblong-lanceolate below to ovate-lanceolate above, the latter attaining a size of 1.2 cm. wide by 6 cm. long, all somewhat obtuse, paler beneath. Cymes rather strict, pedicels rather stiff and 1 to 3.5 cm. long. Sepals narrowly oval, acute, white-scarious margined, about 2 mm. wide by 6 mm. long. Petals 1 cm. long by 5 mm. wide, obovate, the apex emarginate to the depth of about 1.5 mm. Mature pods not seen.

Named in honor of the collector. Type specimens: two sheets, one in the General Herbarium of the Carnegie Museum at Pittsburg, the other in the herbarium of Mr. Roscoe J. Webb, Garrettsville, Ohio.

A cursory examination of the material in the Ohio State Herbarium, State University, Columbus, last spring indicated that there are likely other specimens extant from Ohio localities which belong with our Rocky River specimens thus indicating perhaps a considerable range for our new "variety."

Lycopodium lucidulum porophilum (Lloyd & Underwood) Clute. In August, 1908, a specimen of Club Moss was received from Mr. Almon N. Rood, of Phalanx, Trumbull County, Ohio, with the interesting information that he had found it early in the fall of 1907, growing on the perpendicular face of rocks at Nelson Ledge, Portage County, Ohio. After puzzling over this plant for some time Mr. Rood sent a specimen to a prominent botanist in the East and was informed that it was **L. Selago** L. The plant was growing on cliffs of "sub-carboniferous conglomerate," the height of the cliffs being not over 75 feet and the surroundings in general were not such as would be expected in a locality harboring **L. Selago.**

On August 18, 1908, Prof. L. S. Hopkins and Mr. Roscoe J. Webb, acting under direction of Mr. Rood, found a considerable colony of the plant at the first locality, Nelson Ledges. On the 23d of August, 1908, Mr. Rood and Supt. F. N. Barber, of Crafton, Pa., discovered a second locality for the Club Moss on conglomerate cliffs at Woodworth's Glen, in southern Portage County, Ohio, there being here quite a number of the plants and many of the plants being in inaccessible locations.

The writer has examined a number of these plants and there can be no doubt that they represent true **L. lucidulum porophilum**

first described as a species by Lloyd and Underwood, and ranging from Newfd. and Quebec to Wisconsin and southward to Alabama and the Carolinas. The specimens we have examined clearly point to a subordinate relationship to **Lycopodium lucidulum** Michx. rather than to a distinct specific identity. The leaves are very minutely denticulate to entire instead of toothed as in the species and are generally lance-linear and narrowed from the base upwards instead of being broader above the middle as in true **L. lucidulum.** The plant is being critically studied by Prof. L. S. Hopkins from whom we may expect a more detailed report.

Carnegie Museum, Pittsburg.

A SYNONYMICAL DEFINITION OF NYSSON AND OF N. AURINOTUS.

W. H. Patton.

Acanthostethus, described by Frederick Smith in the Transactions of the Entomological Scoiety of London for 1869, p. 306, was founded on a female specimen of an Australian species, A. basalis Sm. (l c. and pl. vi, f. 3), and is probably identical with the "Spalagia" which is mentioned by Shuckard in Lardner's Encyclopedia, but without a word of description, as an ally of Nysson. Although Mr. Smith does not appear to have appreciated the fact, this insect differs from true Nysson in nothing but the union of the first and second submarginal cells of the forewing, by the obsolescence of the dividing vein; and in this it agrees with the other Australian species, N mysticus Gerst., and with the New Mexican Nysson solani Ckll. (Miscothyris Sm., 1860, is a related Australian genus). The Hyponysson of Mr. Cresson presents a precisely similar peculiarity in that, as he has pointed out, it differs from Nysson in nothing but the union of the third and fourth submarginal cells.

In his monograph* Gerstaecker has shown that Synneurus Costa and Brachystegus Costa, are but synonyms of Nysson, the characters of the presence or absence of a petiole to the third submarginal cell of the forewings and the length of the submedial cell of the hind wings being variable in different individuals of the same species and not being in correlation with any other characters.

Turning now to another group of wasps we find that Miscus and Ammophila are known to be one genus just as Synneurus and Nysson are, and that Coloptera and Ammophila, which I have material for proving to be generically inseparable, have

* Die Arten der Gattung Nysson, Halle, 1867.

differential characters parallel with those separating Acanthostethus and Hyponysson from Nysson proper. It is evident, therefore, that the latter are not independent genera. Further, being based each on a single species (and mostly on a single individual) and defined by a single character known to be individually, and not specifically, variable and which if employed would place a single species in several genera at once, the terms Synneurus, Brachystegus, Acanthostethus (Spalagia) and Hyponysson must be treated as names of artificial groups and cannot be used for the indication of sections or subgenera in the genus Nysson but must be placed as direct synonyms of the genus.

The case of Paranysson is not similar. The character upon which it is founded, the serrate tibiae, may be different in degree in different species and may not in all cases be in correlation with other characters, such as the bilobed postscutellum and the short submedial cell of the hind wings and may therefor fail of full generic value; but, the character being specific, the name Paranysson cannot be quoted as a direct synonym of Nysson, and may be used subgenerically. While it may remain a matter of opinion whether Paranysson should be regarded as a genus and while the consideration of American species alone supports the view that it is a distinct genus (the species with serrate tibiae from both South and North America agreeing in the bilobed postscutellum and in the venation); yet the connection with Nysson, through the European scalaris and militaris, as pointed out by Gerstaecker, is, it seems to me, sufficient to sustain the broader view. Study of the connecting species may discover a generic character in the male eighth ventral segment or in the claspers. The mandibles of Paranysson are much sinuate beneath, of Nysson without sinuation; both not dentate.

If there exists any difference between a genus and a subgenus other than one of degree, this difference is surely that of the nomenclature employed, the name of the genus appearing in the binomial designation of the species and that of the subgenus not so appearing, and no "hedging" is possible in a binomial nomenclature. It is therefore to be regretted that in Mr. Cresson's paper on the "genus Nysson" (Transactions of the American Entomological Society, vol. ix, p. 273, March, 1882), in which he indicates "subgenera," one of which is Paranysson, the inconsistency should appear, on the same page, of adopting Paranysson into the nomenclature of the species with serrate tibiae to the exclusion from that nomenclature of the generic name Nysson; for, notwithstanding Mr. Cresson's use of the words quoted above, he has thus adopted Paranysson as a genus and must be so cited. Foxia (F. pacifica Ashm., Calif.) differs from Nysson in having second recurrent in third submarginal cell, and in ventral segments, 4–5 each having a lateral tooth, ♀ pygidium serrate at tip.

Paranysson texanus Cress.

The following characters pertaining to this species are worthy of note. The second submarginal cell is distinctly five-sided, the submarginal vein being much drawn down to meet the recurrents, the first recurrent being inserted near the base of the cell and the second scarcely beyond the middle; the third submarginal cell has a short side on the marginal. The eleventh and twelfth joints of the male antennae are slightly excavated beneath at base, but the apical joint is not at all excavated. The retracted eighth ventral segment of the male is of a peculiar form and has a deep median slit. (In N. plagiatus and N. aequalis this segment is sinuate-emarginate and the corners are rounded and not of peculiar form.) The tubercles, posterior angles of mesonotum and the sides of the abdominal segments are sometimes ferruginous. I have specimens from Florida (W. H. Ashmead) and Missouri. Specimens of P. fuscipes Cress. from Poway, Calif., (F. E. Blaisdell) indicate that that is but a variety of texanus, as the legs vary from entirely black to mostly red. The specimens from the Atlantic and Pacific slopes agree in all their structural characters, including the form of the seventh and eighth ventral segments and the claspers of the male, and differ only in the more extensive yellow markings on the abdomen of the western variety, a character in agreement with the established rule of geographical colorational variation. Some of the Californian males have a yellow mark on the sides of the seventh abdominal segment. (N. plagiatus from Lake Co., Calif., (O. T. Baron), likewise has more extended yellow marking than the typical variety from Connecticut.) In Mr. Cresson's synopsis of the species of Paranysson and Nysson the systematic value of the coloration of the legs has been greatly exaggerated.

No valid specific characters have yet been pointed out for separating P. mexicanus Cress from texanus.

Paranysson armatus Cress.

I have a male of what appears to be this species from East Tennessee (E. M. Aaron). It differs from Mr. Cresson's description only in having no yellowish spots on the third and fourth segments of the abdomen and in having a small median tubercle near the edge of the clypeus and an angle or short median tooth between the two larger teeth on the seventh abdominal segment, these latter characters not being mentioned in the description of armatus. It agrees with texanus in venation, in the form of the antennae, in having a small tooth on mesopleura and in the presence of a longitudinal ridge on the face and of a longitudinal tubercle on the inner side of each posterior ocellus, and the 7th and 8th ventral segments also agree; its sculpture also and coloration afford no clear characters for distinguishing it from texanus,

but the form of the seventh dorsal segment is sufficient to separate it, armatus having only two distinct teeth on this segment and texanus having four.

Say's description of Nysson aurinotus applies equally well to armatus and to texanus, with the exception of size ("three-tenth of an inch") in which it agrees precisely with armatus, and not a word of his description is at variance with either. But as Say did not mention the armature of the abdomen and probably knew only the female it is hardly safe to adopt his name for one of them to the exclusion of the other. As it is possible that specimens may be found showing connection between the two forms of the seventh segment, it is not impossible that Say's name may yet find recognition, but no such connection is now known. The name given by Say, meaning "gold-known," indicates a very essential and "prominent" character of texanus, and the absence of yellow marks on prothorax and scutellum is characteristic of American Paranyssons and shows clearly that Say's species has no relationship with æqualis. The female specimens from Illinois described by Mr. Cresson under aurinotus belong to N. æqualis Patton. The males of æqualis and N. plagiatus do not differ from one another in form of eighth ventral segment and claspers.

Agenioxenus. To Mr. W. J. Fox is due the credit of referring rufiventris to synonomy with robinsoni Cress. (cf. Tr. A. E. S., 1892, p. 57.) The species is easily distinguished from all others by the male antennæ being longer than both head and thorax. Cresson's figure shows hind cubitus interstitial.

The specimen in the Riley collection should be re-examined, and Walsh's figure compared. The form of prothorax and of metathorax may have been modified in mounting. In Taschenberg's C. abnormis, ♂ from Rio, the venation is as described for Agenioxenus.

THE CLASSIFICATION OF PLANTS, IV.

JOHN H. SCHAFFNER.

The class concept is becoming fairly well established in botany even though one frequently finds groups of very unequal rank designated as classes in recent works. In the last article of the present series of papers, the writer defined a class as "A group of plants in a subkingdom, the members of which show an evident relationship to one another because of similarity of morphological and physiological characters." A diagram was also given showing the approximate relationships of the classes.

There are between forty and fifty plant classes. Of course, it will be recognized that the groups we call classes are of the same rank only in a general sense. In the following scheme forty-six classes, four of them fossil, have been established and are characterized by brief descriptions together with the approximate number of species. The endings of the fungus names have been changed to correspond to Saccardo's views. There should be a uniform system of class endings, but this will come probably only when the class becomes more definitely recognized as a plant group. It might be well in the future to revise some of the class names now in use. It is manifestly absurd to attempt to apply the law of priority in establishing class names. Until very recently the very idea of the class as a definite group from the modern point of view was lacking and our system of the larger groupings is still in its evolution. The arguments adduced for priority in establishing generic and specific names have no weight when applied to the higher groups. From time to time some botanist proposes an improvement and it is thus that a reasonable system will be developed.

In a future paper an attempt will be made to group the classes into proper phyla in harmony with the diagram already published.

I. PROTOPHYTA. 3000 species.

Protophyceae.

1. **Cyanophyceae.** Blue-green Algae. 1000 species.

Nonsexual algae with phycocyanin, blue-green or brownish in color; unicellular, in plates or masses, or in simple or branched filaments; reproduction by simple fission or hormogones, sometimes with specialized resting cells; cell walls usually gelatinous. Typically freshwater plants, frequently occurring in hot springs, some growing in aerial conditions on moist soil, rocks and trees.

2. **Pleurococceae.** 200 species.

Simple nonsexual green algae, unicellular, filamentous, or in colonies; reproduction by fission, by internal division, or by zoospores. Typically freshwater or aerial plants.

Protomycetae.

3. **Schizomycetae.** Bacteria. 1350 species.

Simple unicellular or filamentous fission fungi, parasitic, saprophytic, or holophytic; commonly with flagella or cilia, sometimes moving by means of cell contraction; often producing nonmotile spores which can endure great extremes of heat and cold; reproduction by simple fission, the divisions in one, two, or three directions; cells not naked or ameboid.

4. **Myxoschizomycetae.** Slime Bacteria. 20 species.

Unicellular fission fungi with a slight undulatory motion produced by the contraction of the cell, imbedded in a pseudo-plasmodium and moving about en masse; forming peculiar sporangium-like bodies when passing into the resting or spore stage; cells not amoeboid; saprophytes on decaying organic matter.

5. **Myxomycetae.** Slime Moulds. 400 species.

Unicellular nonsexual mostly terrestrial fungi showing some relationship to the Rhizopoda, occurring in plasmodial masses of more or less completely fused amoeboid cells which finally, with few exceptions, build up complex sporangia-like bodies containing the spores or encysted individuals; spores on germinating giving rise to flagellate naked cells; saprophyts or rarely parasites.

6. **Archimycetae.** 200 species.

Simple parasitic often aquatic fungi without or with a very imperfect mycelium; nonsexual, with zoospores or with thick-walled resting spores; zoospores usually penetrating and developing in a cell of the host plant.

II. NEMATOPHYTA. 57,000 species.

Gamophyceae.

7. **Protococceae.** 230 species.

Simple sexual green algae, single celled or in colonies; usually with normal cells containing one nucleus; reproduction by division, by free swimming gametes, or by motile spermatozoids and stationary eggs.

8. **Hydrodictyeae.** 26 species.

Green coenocytic algae consisting of colonies of peculiar form often very symmetrical; reproduction by the conjugation of equal motile gametes; nonsexual reproduction by zoospores which form new colonies in the parent coenocyte or are discharged in a delicate membrane.

9. **Diatomeae.** Diatoms. 3000 living species.

Single celled or somewhat filamentous algae usually of a brownish color, in which the cell wall becomes silicified and consists of two valves usually with fantastic markings; reproduction by division or by the conjugation of two cells.

10. **Conjugatae.** 1200 species.

Unicellular or filamentous, unbranched, unattached, green, mostly freshwater algae, with a single nucleus and with one or more highly specialized chloroplasts with pyrenoids in the cells; reproduction by division and by zygospores formed by the conjugation of two similar or nearly similar cells, often joined by the development of a special conjugation tube.

11. **Siphoneae.** 625 species.

Coenocytic terrestrial or aquatic green algae usually filamentous, more or less branched, and with or without transverse septa; reproduction by zoospores, by ciliated gametes, or by true sperms and eggs.

12. **Conferveae.** 600 species.

Simple or branched filamentous green algae, sometimes having the cells in discs or sheets, usually attached, having normal cells with one nucleus; reproduction by means of zoospores and by motile gametes or by heterogametes, the egg being stationery; commonly with a primitive alternation of generations; chloroplasts one or more, usually with pyrenoids.

Subclasses, *Isogamae.*
Heterogamae.

13. **Phaeosporeae.** 385 species.

Normally brown-colored marine algae ranging from rather simple filamentous forms to very large, highly developed organisms with a distinct conducting tissue whose cells contain sieve plates; usually attached, the frond often differentiated into stem and leaf-like structures; reproduction by zoospores produced in unilocular sporangia, and motile gametes produced in plurilocular sporangia; both types of sporangia exposed.

14. **Cyclosporeae.** 316 Species.

Medium to large, marine, brown algae, attached, branched, and usually flattish; reproduction by small biciliate sperms and large non-ciliated eggs which are discharged and fertilized in the water; reproductive organs sunken in conceptacles.

15. **Dictyoteae.** 82 species.

Erect, attached, marine, brown algae with flat leaf-like fronds; nonsexual reproduction by nonmotile tetraspores; sexual reproduction by means of non-ciliated eggs produced singly and finally discharged from the oogonium, and sperms with one flagellum produced in many-celled antheridia.

16. **Bangieae.** 46 species.

Marine or freshwater red or purple algae with filamentous or thalloid fronds; reproduction by single thallus cells and by the production of antheridia and oogonia from ordinary thallus cells, the antheridium developing nonciliated sperms, the oogonium which is without a distinct trichogyne usually developing a single stationary egg.

17. **Florideae.** 1835 species.

Mostly marine red or purple algae, often of considerable size, filamentous or thalloid; reproduction by means of non-ciliated sperms produced in antheridia consisting of definite groups of cells, and eggs produced singly in the base of an oogonium which is prolonged above into a slender trichogyne. Plants with a definite alternation of generations the fertilized egg having a complicated development but in the simpler cases giving rise to a juvenile sporophyte body from which one to many carpospores are produced which on germination develop into a second sporophyte stage on which tetraspores are produced from which the gametophyte is again propagated.

18. **Chareae.** Stoneworts. 160 species.

Green filamentous erect, mostly freshwater algae, attached at the base by means of rhizoids, with stems distinctly segmented into nodes and internodes, the nodes being marked by whorls of branches; plants usually with an incrustation of lime and the cells of the stem and branches often covered with a cortical layer of smaller cells; without an alternation of generations; oogonia rounded covered by a cortical layer of branches, antheridia compound and very complex composed of united branches to form a hollow globular structure containing sperm-bearing filaments; spermatozoids spirally coiled, biciliate; no nonsexual spores present.

Eumycetae.

19. **Monoblepharideae.** 6 species.

Small coenocytic fungi with a nonseptate or nearly nonseptate mycelium, with uniciliated zoospores and with a typical sexual reproduction; saprophytic and aquatic; eggs stationary in the oogonium which opens to admit the uniciliated spermatozoids

20. **Zygomycetae.** 180 species.

Saprophytic or parasitic fungi with a nonseptate or nearly nonseptate mycelium having a conjugation of equal or nearly equal branches, one of which does not penetrate the other to any extent, the result of conjugation being a simple or coenocytic zygospore; sometimes parthenogenetic; nonsexual spores usually non-motile.

21. **Oomycetae.** 185 species.

Mostly parasitic fungi with a nonseptate or nearly nonseptate mycelium, with conjugating branches, the one being much larger than the other which penetrates into its interior, the result being a simple or coenocytic sexual spore; sometimes parthenogenetic; nonsexual motile spores also produced which frequently develop in conidia.

22. **Ascomycetae.** 12,250 species, besides 8,250 Lichens and 13,500 Deuteromycetae.

Parasitic or saprophytic fungi with a septate mycelium and asci usually containing a definite number of ascospores, the asci often produced as the result of a conjugation of two branches of the mycelium, or sometimes by a more highly developed sexual process; conidiospores commonly developed, in many groups the conidial stage only being known.

Subclasses, *Hemiascae*
Exoascae
Discomycetae
Pyrenomycetae
Discolichenes
Pyrenolichenes
Deuteromycetae

23. **Laboulbenieae.** 150 species.
Minute fungi with a septate body parasitic upon insects, usually beetles, connected with the host by means of a dark-colored horny base serving as an organ of absorption and a holdfast; oogonium with a slender projection, the trichogyne, to which the nonmotile spermatia become attached, finally fertilizing the oosphere below; as the result of fertilization a number of sacs or asci are produced which contain the nonsexual ascospores.

24. **Teliosporeae.** 2100 species.
Parasitic fungi with the septate mycelium developed in the tissues of the host, finally productiing teliospores which give rise to septate or nonseptate basidia on which basidiospores are produced; some groups producing five kinds of spores, often heteroecious; especially abundant on plants of the Grass family.

25. **Basidiomycetae.** 10,000 species.
Mostly large saprophytic, rarely parasitic, fungi with a septate mycelium; developing septate or nonseptate basidia on the vegetative mycelium, no teleospores being produced; basidia usually with two or four spores.

Subclasses, *Protobasidiae*
Hymenomycetae
Gasteromycetae
Hymenolichenes.

III. BRYOPHYTA. 17,000 species.

26. **Hepaticae.** Liverworts. 3875 species.
Gametophyte thalloid or a stem-like frond with scales which are without a costa, mostly dorsiventral, usually with a sack-like envelope, the perigynium, around the archegona; rhizoids thread-like and unicellular; protonema usually small or only slightly developed, transient. Sporophyte either a spherical sporangium without foot or stalk, or differentiated into sporangium, foot and

elastically elongating stalk; sporangium without columella, usually with elaters, indehiscent, irregularly dehiscent at the top, or splitting into four valves from the summit, rarely developing an operculum.

27. **Sphagneae.** Bog-mosses. 250 species.

Gametophyte a stem-like, erect, light, gray-green frond without a true central strand but with large cortical cells, bearing numerous scales without a costa but with two kinds of cells, narrow ones with chlorophyll and large ones without, but with holes in the walls; rhizoids septate; protonema finally thalloid and flat; fruiting plant developing one or more pseudopodia which support the sporophytes. Sporophyte without a stalk but with an expanded foot; sporangium with a shallow dome-shaped spore cavity in the upper part and with an operculum but without a peristome, elaters, or air cavities. Growing in bogs and wet places.

28. **Andreaeae.** Granite-mosses. 105 species.

Gametophyte a stem-like, erect frond without a central strand, bearing numerous scales without or with a costa; rhizoids consisting of cylindrical masses or plates of cells; protonema more or less thalloid. Sporophyte without a seta but with a foot and finally carried upon a pseudopodium; sporangium without air cavities, splitting into four or more valves which are at first united at the top, spore cavity cylindrical dome-shaped with an upward projecting central columella; elaters none; calyptra present on the sporophyte. Caespitose plants of a dark brown color growing on rocks.

29. **Musci.** Mosses. 12,500 species.

Gametophyte a stem-like, erect or prostrate frond usually with a well-developed central strand and with costate scales; rhizoids filamentous, septate; protonema usually well-developed and filamentous, sometimes persistent; pseudopodium none. Sporophyte well-developed with sporangium, foot, and usually with a well-developed hypophysis and a seta with a central strand; sporangium usually with an operculum and a central columella extending entirely through the spore cavity, usually with a well-developed peristome and air spaces often communicating on the outside with stomata; venter of the archegonium enlarging and usually ruptured at the base, the upper part being carried on top of the sporangium as the calyptra.

30. **Anthocerotes.** Horned Liverworts. 103 species.

Gametophyte a dorsiventral thalloid frond without scales or with imperfectly developed scales but with unicellular rhizoids; sexual organs imbedded in the tissue of the thallus; protonema small and transient. Sporophyte with a slender horn-like or

pod-like sporangium and with a bulbous foot containing an irregular surface with wart-like projections; sporangium with a central columella, two-valved, with small irregular elaters among the spores; epidermis with or without stomata; cells with a single large chloroplast.

IV. PTERIDOPHYTA HOMOSPORAE. 4,500 species.

31. **Filices.** Ferns. 4,000 living species.

Sporophyte herbaceous or tree-like, usually with a horizontal rhizome, simple or branched; leaves usually large, alternate and mostly compound, rarely grass-like; sporangia borne on the under side of the leaves or on simple or branched sporangiophores; eusporangiate or leptosporangiate; sporophylls not forming cones. Gametophyte comparatively large, tuber-like without chlorophyll and subterranean, or developed as a flat, simple or branched thallus, hermaphrodite or unisexual; spermatozoids multiciliate.

Subclasses *Eusporangiatae*
Leptosporangiatae.

32. **Equiseteae.** Horsetails. 25 species.

Sporophyte perennial, herbaceous, with a rhizome, and with jointed, mostly hollow, simple or branched, aerial stems which are either annual or perennial; vascular bundles in a circle; leaves reduced to sheaths around the joints, the sheaths toothed; sporangia borne on small peltate sporophylls arranged in whorls on a terminal cone; eusporangiate; spores with four narrow, strap-like, hygroscopic appendages. Gametophyte a small green thallus, usually unisexual; spermatozoids multiciliate.

33. **Lycopodieae.** Lycopods. 155 species.

Sporophyte perennial, herbaceous, with or without a rhizome, the aerial stems upright or trailing; branching monopodial or dichotomous; leaves small, without a ligule, scattered on the stem, into two to many ranks; sporangia solitary on the upper surface of the leaves or in their axils, eusporangiate; sporophylls in bands alternating with the sterile leaves or arranged in spirals in terminal cones; spores small, not appendaged. Gametophyte small, sometimes subterranean, with or without chlorophyll, hermaphrodite; spermatozoids biciliate.

V. PTERIDOPHYTA HETEROSPORAE. 700 species.

34. **Calamarieae.** Fossil.

Paleozoic plants, sometimes of tree-like aspect and dimensions, with hollow-jointed stems with a circle of collateral vascular bundles; stems increasing in diameter by a cambium zone; heterosporous, the sporophylls in cones.

35. **Sphenophylleae.** Fossil.

Paleozoic plants of tree-like aspect and dimensions, with solid jointed stems with a central triarch vascular bundle; leaves wedge shaped, comparatively small; probably heterosporous, the sporophylls in cones.

36. **Hydropterides.** Water-ferns. 75 species.

Sporophyte with a horizontal rhizome or floating on the surface of the water; leaves alternate or whorled; microsporangia and megasporangia borne together enclosed in sporocarps, leptosporangiate. Gametophytes developing entirely within the spore walls or protruding only slightly, very short lived; spermatozoids large, spirally coiled, multiciliate.

37. **Isoeteae.** Quillworts. 60 species.

Sporophyte with a short tuberous stem with a peculiar type of secondary thickening and with long, erect, grass-like leaves which have a ligule; roots dichotomous; microsporangia and megasporangia large, borne singly, sunken in the expanded bases of the leaves, eusporangiate. Gametophytes very much reduced; spermatozoids spirally coiled, multiciliate.

38. **Selaginelleae.** Selaginellas. 500 species.

Sporophyte dorsiventral or erect, with monopodial or dichotomous branching and dichotomous roots; leaves small, opposite or spirally arranged, ligulate; cells often with a single chloroplast; sporophylls in bisporangiate cones, the eusporangiate microsporangia and megasporangia single in the axils of the sporophylls. Gametophytes small and short-lived; spermatozoids very minute, biciliate. Some fossil species developed as large trees with secondary thickening by a cortical meristem.

VI. GYMNOSPERMAE. 500 living species.

39. **Pteridospermae.** Fossil.

Paleozoic seed plants of fern-like aspect; stems short and erect, increasing in thickness, bearing compound leaves.

40. **Cycadeae.** Cycads. 90 species.

Sporophyte with erect, woody, simple or little-branched stems, bearing compound leaves; vascular bundles collateral concentrically arranged, increasing in thickness by their cambium; cortical meristem developed in which new bundles are produced; sporophylls in cones, or the carpels sometimes merely in whorls through which the stem grows; ovule with pollen-chamber; female gametophyte becoming large and fleshy; male gametophyte developing two or more large spirally coiled multiciliate spermatozoids.

41. **Cordaiteae.** Fossil.

Paleozoic branching trees bearing large, long, thick parallel-veined leaves spirally arranged.

42. **Ginkgoeae.** Maiden-hair-trees. 1 living species.

Sporophytes developing into large trees with a cambium layer from which annual rings of wood are produced, with numerous, large, wart-like dwarf branches on the ordinary branches; leaves deciduous, broad, with dichotomous venation, borne in clusters on the dwarf branches or alternate on ordinary branches; flowers monosporangiate, dioecious; ovule with pollen-chamber; cotyledons, 2, the embryo not developing until the seed falls to the ground; female gametophyte becoming large in the seed which has a bony inner and a fleshy outer coat; male gametophyte developing 2 large spirally coiled multiciliate spermatozoids.

43. **Coniferae.** Conifers. 350 species.

Sporophytes developing as shrubs or large trees, much branched, with or without dwarf branches; stems with a normal cambium, no vessels in the secondary wood, resin nearly always present; leaves mostly small, entire, linear, lanceolate, subulate, or scale-like; flowers monosporangiate, monoecious or dioecious; seeds and female gametophyte rather small, ovules without pollen-chamber, cotyledons 2–15, always free; sperm cells 2, not motile, no cilia being present.

44. **Gneteae.** 50 species.

Sporophytes developing as shrubs, trees, or woody climbers, with branched or simple stems containing vessels in the secondary wood; leaves simple and opposite; flowers monoecious; seeds naked, orthotropous; cotyledons two; resin passages none; gametophytes various.

VII. ANGIOSPERMAE. 125,000 species.

45. **Monocotylae.** Monocotyls. 24,000 species.

Sporophytes developing as herbs or sometimes as woody plants of large dimensions, embryo usually with one terminal cotyledon and usually with a lateral plumule; stem with closed, usually scattered vascular bundles, without typical bark and annual rings of growth, rarely with secondary thickening; leaves mostly parallel-veined, sometimes netted-veined; flowers more commonly trimerous.

Subclasses, *Helobiae*
Spadiciflorae
Glumiflorae
Liliiflorae

46. **Dicotylae.** Dicotyls. 100,000 species.

Sporophytes developing as herbs or woody plants; embryo with two cotyledons, rarely with more or only one, and with a terminal plumule; stem with open vascular bundles, usually

arranged in a circle and developing a continuous cambium cylinder, forming annual rings of growth in the case of perennial stems, with bark on the outside; leaves usually netted-veined; flowers more commonly pentamerous or tetramerous.

Subclasses, *Choripetalae*
Centrospermae
Apetalae
Heteromerae
Sympetalae Hypogynae
Sympetalae Epigynae

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, NOV. 2, 1908.

The minutes of the previous meeting were read and approved as read, after which the following, proposed at the last meeting, were elected to membership: B. M. Wells, Geo. Simmons, Clyde Miller, and John Foreman.

The nominating committee submitted the following names for officers of the club during the coming year:

President, Miss Freda Detmers; Vice President, H. H. Severin; Secretary-Treasurer, Arthur H. McCray.

The persons named were unanimously elected.

The program of the evening consisted of the president's annual address by Dr. Geo. D. Hubbard.

The retiring president presented a preliminary report on the physiography of the four local quadrangles, covered by the Dublin, Westerville, East Columbus, and West Columbus topographic maps of the United States Geological Survey. He had done the work during the last year or more under the direction of the Geological Survey of Ohio, which organization is looking forward to the preparation of a bulletin discussing the geology, mineral and rock resources and physiography of this region.

The area is about 27 miles east and west by about 35 north and south with Columbus near the center. At present, physiographically, it consists of a young till plain adorned with one large morainic belt in the northern part and several smaller moraines looped across it from east to west; with scattered kames and kame areas, and eskers; with kettle ponds and swamps usually now extinct; and the whole in a very youthful stage of dissection.

The moraines were left by the halting retreat of the Late Wisconsin ice sheet, while the till plain is the aggregate accumulation of drift from two or more ice invasions. Many localities were mentioned where drift older than the surface material had been

studied. The Powell moraine is the largest and was described in detail by Leverett several years ago. The kames are well illustrated by Spangler's hill now the site of the Hartman farms, by Baker's hill just south of Columbus and by a group of hills north of Canal Winchester; and the eskers are illustrated by a fine example over two miles long crossing the National Pike at Hibernia, and by another a mile or more south-east of Canal Winchester.

Post-glacial dissection of these glacial features, especially the till plain, has given rise to the four large north-south valleys and the multitude of short, steep-sided gorges.

These gorges and many well records have revealed much concerning the rock surface beneath the drift. This part of the study is yet incomplete but it has proceeded far enough to determine that there is very little agreement between the present topography and that of the rock below. The latter has broad elevations and broader shallow depressions which are probably portions of very mature divides and valleys. Because of their great maturity it seems that these features must have developed preglacially. The rock surface also has many narrow, steep-sided valleys now drift filled. No system has yet been worked out to which these valleys can be referred but they were undoubtedly due to erosion in interglacial periods, and there may be as many systems of these valleys, now filled and buried, as there have been interglacial periods.

The field work in this area will be continued, and the bulletin containing the completed report published as soon as possible.

Prof. Griggs moved that a committee be appointed to consider a new night for the meetings of the club. The motion was unanimously carried after which the club adjourned.

ARTHUR H. McCRAY, Secretary.

CORRECTION.

In the paper entitled "Rock Terraces Along the Streams near Columbus, Ohio," in the December, 1908, Ohio Naturalist, p. 398 the sentence beginning on line 1 should read: "The rocks along the Scioto and Olentangy rivers is all of Devonian age; two rather resistant limestones—the Columbus and Delaware—and two much less resistant shales above—the Olentangy and Ohio. Along the Big Darby the Columbus shows, and also below it the equally resistant Monroe limestone of Silurian age."

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NOTES ON GUATEMALAN HEMIPTERA WITH DESCRIPTIONS OF A FEW NEW SPECIES.

HERBERT OSBORN.

During the winter of 1905 Prof. J. S. Hine made a collecting trip in Guatemala and the Hemiptera collected, except the aquatics, have been turned over to me. As the material in this collection adds new localities for many of the species recorded in the Biologia Centrali Americana, in some instances entirely new records for the Central American region, and also some few species that appear to be new to science, it seems desirable to give a list of all the species so far as determined with the records of the localities where collected and such notes on distribution as may add to our knowledge of the geographical range of the species. The localities worked by Prof. Hine were Puerto Barrios near the coast and Morales, Los Amates, Gaulan, for the Atlantic slope; and Guatemala City, Amatitlan, Santa Lucia, Mazatenango, San José, for the Pacific slope. Considering the time during which the collections were made and that quite a number of species are still undetermined, this list must be considered as quite extended particularly if we note that Hemiptera were only one group in which collections were made.

As it is but a few years since the appearance of the "Biologia" articles on Hemiptera of this region, it seems unnecessary to attempt a full bibliography and only such citations of references or synonomy are given as seem necessary to properly locate the species or to correct what appear to be erroneous references in previous articles. The work in the "Biologia" seems to have been done with too little regard to determination of the previously described forms and there is a large number of new species described which will probably have to be reduced to synonyms when the fauna is more carefully worked.

It will be noticed that while a considerable number of species in this list corresponds with the nearctic representatives of our own latitude, the great majority are different. A considerable number are South American and so far as records show many are restricted in range to the Central American region. While these records will be of service in deductions concerning the relationship of this fauna it is not my purpose here to go into any discussion of the geographical affinities. This can better be done in connection with discussions of the geographical range in particular families.

MEMBRACIDAE.

Pterygia bituberculata Fowl.

One good example of this species from Los Amates agrees closely with Fowler's description and figure. I have not seen hispida Fairmaire and cannot determine as to distinctness of the two species.

Sphongophorus ballista.

Taken at Puerto Barrios, March 3d, and Livingston, March 5, 1905. Certainly one of the most grotesque of this peculiar group.

Bolbonota pictipennis Fairm.

From Puerto Barrios, March 3d.

Tylopelta gibbera Stal.

Puerto Barrios, March 3d, evidently fairly common, the collection including nine examples.

Aconophora temaxia Fowler.

Four females, six males Puerto Barrios, March 3d.

Fowler's description is based on three females only. The males associated here differ from the females in being smaller and of a darker color the pronotal horn slightly shorter but otherwise very similar.

Aconophora nigra Stal.

A single specimen from Puerto Barrios, March 3d, and one from Mazatenango Feb. 3d.

Hyphonœ asphaltina Fairm.

A number of specimens of this common species from Puerto Barrios, and Los Amates. These show quite a little variation in size and convexity of anterior face of pronotum.

Acutalis fusconervosa Fairm.

One specimen, collected at Los Amates in February, and four from Mazatenango February 3d. The anterior face of pronotum is decidedly tawny.

Micrutalis lugubrina Stal.

One specimen, Los Amates, is referred here. In some points it agrees with the variety, parallela of Fowler.

Micrutalis binaria Fairm.

One specimen from Puerto Barrios (March) two from Los Amates (January and February). Evidently not common.

Micrutalis malleifera Fowler.

Los Amates, January, 1905. Santa Lucia, February 2, 1905. Two specimens from Gaulan, differ from the more typical example and possibly represent another species.

Cyphonia clavata Fab.

A good series of this very striking species from Puerto Barrios (March) and Los Amates and Mazatenango (February). Fowler records it for Guatemala only from Mirandilla.

Poppea munda Fowler.

A single specimen collected at Puerto Barrios March 3, 1905. The species was described by Fowler as from one locality only. "Panama, Caldera in Chiriqui 1200 feet (Champion)."

Polyglypta maculata Burm.

The single specimen referred here was taken at San Pedro in February. While it might easily be referred to some of the described varieties of dorsalis, it seems on the whole to agree best with this species.

Enchenopa lanceolatum Fab.

Membracis lanceolatum Fab. Mant Ins II p. 263, 10 (1787).
Enchophyllum (Tropodocera) lanceolatum Fabr. Stal. Hemipt. Fabricana, 2, 42
Enchenopa, lanceolata Fowler, Biol Cent. Em 1, 9

Two specimens Puerto Barrios. Four specimens Los Amates, February and March.

These differ from our northern form of E. binotata in having the pronotal horn longer and more curved, the tip much less expanded laterally, and the carinæ at base fewer and less distinct so that I conclude they must be referred here, rather than to binotata, in spite of Fowler's statement that it does not occur in the northern part of Central America.

Ceresa vitula Fab.

Puerto Barrios, Los Amates, Mazatenango. These specimens correspond closely with the var. minor of Fowler, but whether they merit varietal rank seems doubtful.

Stictocephala sp.

One specimen Santa Lucia Feb. 2, 1905.

Stictocephala dubia Fowler.

Two specimens taken at Gaulan Feb. 2, 1905. It seems very probable that this species will prove to be a synonym of some of the earlier described forms but I have not material at hand to undertake a comparison.

Sphaerocentrus curvidens Fairm.

One specimen, Los Amates, February, 1905.

Brachybelus cruralis Stal.

Three specimens from Los Amates and one from Puerto Barrios are referred here. They vary considerably in size but in other characters seem too closely related to merit separation.

CERCOPIDAE.

Tomaspis postica Walk.

Monecphera postica Walker, List, Hom Sus Suppl 177
Tomaspis pictipennis Stal Stett Ent Zeit 25, 63
Tomaspis postica Fowl Biol Cent Am Hom II 184
Tomaspis jugata Fowl Biol Cent Am Hom II 183

A good series of 21 specimens are in hand from Puerto Barrios, Panzos and Los Amates. Also from San Pedros, Hond Feb 21, 1905 (E B. W)* Some of the smaller specimens agree so perfectly with Fowler's jugata that I feel convinced that this should be considered a synonym

Tomaspis bicincta Say

Several specimens collected at Puerto Barrios in early March

Clastoptera compta Fowl

Abundant, Los Amates Puerto Barrios

Clastoptera funesta Stal

Los Amates, Panzos, Santa Lucia and Mazatenango (January, February and March) These specimens vary considerably in presence or absence of the yellow markings but seem to belong together

TETTIGONIDAE

Phera atra Walk

One specimen Puerto Cortez, Honduras, March 23, 1905 Two specimens Puerto Barrios, March 3, 1905

Phera centrolineata Sign

One specimen Mazatenango, Feb 3, 1905

Oncometopia invidenda Fowler, Biol Cent Am

Morales, March 8, 1905 A good series of eight specimens.

Oncometopia speculifera Sign

One specimen from Los Amates, Feb 18th

Oncometopia anceps, Fowl

Two specimens Feb 17, 1905

Oncometopia obtusa, Fab.

Oncometopia interjecta, Fowler, Biol Cent Am Homp 11, 228

A series of 6 specimens varying much in color, especially underneath, but with apparently constant color pattern. These appear to me to include the form described and figured as interjecta by Fowler. One specimen otherwise apparently identical is only about half the size of the others, 9 m. m., against 14.5 in length for the large individuals.

* E. B. Williamson, to whom a number of records in Honduras are due.

Dilobopterus 5-signata Walk.

One specimen Los Amates Feb. 17, 1905.

Tettigoniella redundans, Fowl.

Taken at Los Amates, Feb. 18–26, Mazatenango, Feb. 3, 1905.

Tettigoniella Stali var. **fractinota** Fowl.

Puerto Barrios March 3d, Los Amates Feb. 28, 1905. Mazatenango, Feb. 3d. Also at San Pedro, Hoduras, Feb. 21, 1905. (E. B. W.)

Tettigoniella pulchella, Fab

An abundant and widely distributed species. Los Amates, Feb. 17, 1905. Santa Lucia, Feb. 2d, 1905. Gaulan, Feb. 14th, 1905. Also at San Pedro Honduras, Feb. 21, 1905 (E. B. W.).

Tettigoniella jucunda,- Walk.

Taken abundantly at Los Amates, Feb. 18–28, 1905. Puerto Barrios, also San Pedro, Honduras, Feb. 21, 1905 (E. B. W.)

Tettigoniella laudata, Walk.

Los Amates, Feb. 17. Puerto Barrios, March 3d. Also San Pedro, Honduras, Feb. 21, 1905 (E. B. W.)

Tettigoniella areolata Sign.

Gualan, Feb. 14th. Mazatenango, Feb. 3, 1905. Apparently an abundant species at these points.

Tettogoniella 6-guttata, Fab.

Mazatenango, Feb. 3d.

Tettigoniella bifida Say. var. **fuscolineella** Fowl.

Tettigonia fuscolincella Fowl, Biol. Cent. Am. Homop II, 290.

Los Amates, Jan. 17th, Panzos, March 18th. Mazatenango, Feb. 3d, Santa Lucia, Feb. 2d. Also San Pedro, Honduras, Feb. 21, 1905 (E. B. W.)

While there is quite constant difference between the Central American forms and our northern bifida especially in the shorter vertex and brown face, it seems quite probable that the difference is varietal rather than specific.

Tettigoniella geometrica Sign.

Tettigonia psittacella, Fowl. Biol. Cent. Am Homop, II. 290.

This species was taken at Los Amates in January and February and at Mazatenango, Feb. 3d. I see no basis for separating Fowler's species from Signorets and probably he was not familiar with the latter.

Tettigoniella satelles Fowl.

Two specimens, Los Amates, Feb. 18–28, 1905.

Tettigoniella virgaticeps Fowl.

One specimen Puerto Barrios, March 3, 1905.

Tettigoniella caeruleovittata Sign.

Among the many specimens of this species, there are two fairly well marked color varieties, one considerably darker than the other. Aguas Calientes, Jan. 28th, Mazatenango Feb. 3d, Los Amates, Feb. 18–28, 1905.

Tettigoniella miniaticeps, Fowl.

Common, Puerto Barrios, March 3d, Los Amates, Jan. 17. Also San Pedro, Honduras, Feb. 21, 1905 (E. B. W.)

Tettigoniella venusta Stal.

Two specimens from Santa Lucia Feb. 2, 1905.

Tettigoniella reservata Fowl.

Two specimens, Los Amates, Jan 17th and Feb 18th.

Tettigoniella rufimargo Walk

Los Amates January and February.

Tettigoniella occatoria Say.

Apparently very abundant and specimens are included from Mazatenango, Feb 3d, Los Amates, Feb. 18–28, Puerto Barrios, March 3d, 1905. San Pedro, Honduras Feb 21, 1905 (E. B. W.).

Tettigoniella mollicella Fowler.

Los Amates Jan. 17th. Gaulan Feb. 14, 1905.

Tettigoniella sexlineata Sig.

Plentiful at Los Amates, Feb. 18–28.

Tettigoniella lativittata Fowl.

A good series from Los Amates, Feb. 18–28. One, San Pedro, Honduras, Feb. 21, 1905 (E B. W.)

Tettigoniella similis Walker.

Tettigonia prolixa, Fowl Biol Cent. Am Homop. II, 275

Of this widespread and abundant species numerous examples are in hand from Mazatenango, Feb. 3d, Los Amates, Puerto Barrios, March 3d, Santa Lucia, Feb. 2d. Also, San Pedro, Honduras, Feb. 21, 1905 (E. B. W.)

Tettigoniella salutaris, Fowl.

One specimen Los Amates, Feb. 1905.

Diedrocephala sanguinolenta Fab.

Cicada sanguinolenta Fab.

Tettigonia sanguinolenta, Sign. Ann Ent Soc. Fr.; Fowler Biol Cent. Am. Homop. II, 262.

This common species appears in number in collections at Puerto Barrios, March 3d, Los Amates, Feb. 18–28, Mazatenango, Feb. 3d. Two, San Pedro, Honduras, Feb. 21, 1905. (E. B. W.)

Diedrocephala variegata Fab.

Cicada variegata Fab.

Tettigonia variegata, Fowler, Biol. Cent. Am. Homop. II, 291.

One specimen Los Amates, Feb. 16–28.

Diedrocephala versuta Say. var. **lineiceps** Spin.
Santa Lucia, Feb. 3d, Mazatenango, Feb. 3, 1905.

Diedrocephala rufoapicata Fowl.
Tettigonia rufoapicata Fowl. Biol Cent Am. Homop. II, 206.
A single specimen Los Amates Jan. 17th. The species appears well marked but will come under Diedrocephala as now defined.

Diedrocephala orbata Fowl.
Tettigonia orbata Fowler, Biol. Cent. Am. Homop. II, 286.
Puerto Barrios, March 3d, Los Amates, Jan. 17th.

Diedrocephala limbaticollis Stal.
Tettigonia limbaticollis, Stal. Ent Zeit., Stett. 25. 75; Fowler, Biol Cent Am Homop. II, 279
Los Amates, Feb. 18–28, Puerto Barrios, March 3d

Draeculacephala reticulata Sign.
Santa Lucia Feb. 2, 1905.

Draeculacephala mollipes, Say.
Abundant at Santa Lucia on Pacific Slope, Feb. 2, 1905.

Draeculacephala mollipes Say, var. **minor** Walk.
Taken in large numbers at Mazatenango, Feb 3d. Also at San Pedro, Honduras, Feb. 21, 1905 (E. B. W.) This variety seems to have been the only form taken at most of the Atlantic slope stations while typical mollipes occurred very abundantly on Pacific slope. The varietal character is apparently very well established and in this instance seems to be associated with geographic limitations.

Gypona unicolor Stal.
One specimen Santa Lucia, Feb. 2d.

Gypona germari Stal.
Los Amates, Jan. 17, Mazatenango, Feb 3d, Puerto Barrios, March 3d.

Gypona bigemmis Spang.
Puerto Barrios, March 3d.

Gypona punctipennis Stal.
Los Amates, Jan. 17th, one specimen.

Gypona proscripta Fowler--conspersa Spang.?
One specimen Mazatenango, Feb. 3, 1905.

Gypona fuscinervis Stal.
One specimen, Panzos, March 18, 1905.

Gypona teapensis Fowl.
One specimen Los Amates, Jan. 17, 1905.

Gypona vinula Stal.
Three specimens Mazatenango, Feb. 3, 1905.

JASSIDAE.

Dorydium maculatum, n. sp.

Light cinereus with brown or fuscous on vertex, pronotum and elytra. Vertex at tip, sinuous lines on the face, clypeus, coxæ, pectus and spots on the legs black. Length of female 5 m. m.; male 4 m. m.

Head with eyes scarcely wider than the pronotum, eyes large, vertex narrow, about three times as long as width between eyes, flat faintly impressed on median line and with slight depression on disk and next the tip. Apex acute, slightly upturned, front rather strongly keeled at tip becoming convex at clypeus. Clypeus with parallel sides nearly twice as long as wide; lorae longer than wide, outer margin nearly semi-circular not reaching margin of cheek Genae broad rather deeply sinuate behind the eye. Rostrum shorter than clypeus Pronotum strongly arched in front, lateral margin short, hind margin slightly concave, surface minutely striated or faintly rugose on central part, not carinate; scutellum with apex very acute, length scarcely equal to the width at base, elytra opaque except for small sub-hyaline areas in first, second, third and fifth apical cells and anteapical and discal cells Clavus with two veins situated rather close together the outer one remote from claval suture; corium with five apical, one ante-apical and two discal cells; the costal veins reflexed; the vein below anteapical cell expanded into a minute cellule

Color cinereous or somewhat stramineus with light brown markings on vertex, forming a large discal spot in front of middle, two marginal triangular spots, and central transverse band with more definite spots toward the margin, and a central line running backward, another brownish band between the eyes with darker spots toward the center, pronotum with three indefinite brownish longitudinal stripes, a pair of dark brown slightly infuscated spots on anterior margin, the outer longitudinal stripes and the spot behind the eye fuscous; scutellum with a basal median spot and anteapical arch broadening at margin, fuscous two spots in basal portion of clavus, two on the disk, and sutural line and the reflexed costal veins and spot on inner apical veinule dark fuscous or blackish. Face with the tip of vertex black; face with somewhat broken sinuate lines each side, fuscous or blackish lower part of face including most of clypeus and cheeks below the lorae black, and propleural spots and spots on the pectus, tarsal claws on front and middle feet and a series of spots at base of spines, apex of tibia, apex of tarsal joints and claws of hind feet black. Line on the inner side of hind tibia black All marks are more intense in the male but color pattern is identical

Genitalia: Last ventral segment of female about as long as the preceding, hind margin not produced, slightly sinuate, ovipositor exceeding the pygofer by about ¼ its length and tipped with reddish; the male valve hidden under last ventral segment, plates and pygofer very short, the former thick narrow and reaching the lower apex of pygofer. Pygofer obliquely truncate, margins meeting ventrally in an obtuse angle.

Described from a series of five specimens collected at Los Amates, Guatemala, by Prof. J. S. Hine, Jan. 17, 1905. It is an interesting addition to the Dorydine fauna differing quite distinctly from the European representatives of the genus.

Scaphoideus scalaris Van D.

Mazatenango, Feb. 3d. Originally described from California the species is now known from Washington and New York

through Mexico, and now to Guatemala the most southerly point yet recorded. It is perhaps worthy of note that these specimens have typical form of head and do not approach the form described from Mexico as mexicana by the writer.

Scaphoideus tesselatus n. sp.

Size and general facies of scalaris but conspicuously tesselate; elytral veins conspicuously marked with alternating black and white spots. Female, length 5 m. m.

Head distinctly angulate, sub-conical; vertex margins sloping, length about equal to width between eyes; front elongate, narrowing slightly to clypeus. Clypeus about twice as long as broad, slightly wider at apex; lorae very large reaching almost the border of the cheeks which form a very narrow margin; genae very slightly sinuate; antennae very long, extending almost to tip of abdomen Pronotum strongly arcuate in front; truncate behind; lateral margins very short Costal nervures not reflexed; first one opposite basal part of outer ante-apical cell, ante-apical cells equal, parallel margined; apical cells sub-equal in size .

Color. Vertex blackish with two small whitish points at extreme apex; two small semi-circular spots between ocelli, behind which are two brownish depressed sub-triangular spots; faint median whitish line and faint whitish borders at occiput against the eyes and distinct whitish circles around ocelli Face brownish; border next the vertex black, margined by sinuate whitish line; antennae pallid brownish at base, seta darker; pronotum brown with darker fuscous on anterior border and irrorate with transverse whitish spots; scutellum fulvus at center, two fuscous spots each side, basal angles and apex yellowish white. Elytra golden brown with dark fuscous or blackish on the veins and at apex of clavus, interrupted by conspicuous white spots; three larger whitish spots on clavus; two on the sutural margin; one near the base next claval suture; three larger whitish spots on corium two corresponding with transverse veinules and one on first costal cross vein. Apical veins broadly margined with smoky fuscous.

Genitalia: Last ventral segment of female nearly twice as long as the penultinate; broadly excavate and with a broad rather blunt median tooth; pygofers rather narrow, as long as ovipositor, narrowed posteriorly with rather stiff short bristles arranged in two somewhat irregular series each side.

The single specimen of female was collected by Prof. J. S. Hine at Los Amates, Guatemala, Feb. 18–05. While distinctly belonging to the scalaris group, it is very distict indeed from any of the known species. Its handsome checkered appearance will readily distinguish it.

Chlorotettix vittata. n. sp.

Greenish white with distinct fusco-hyaline lines on elytra. Female length to tip of elytra 7 m. m., male 6.75 m. m.

Head scarcely as broad as pronotum; vertex round in front, scarcely longer at middle than next the eye; front narrowed apically; clypeus widened at apex; lorae eliptical, rather narrow; genae with sinuate margin. Pronotum concave behind; elytra sub-hyaline, veins small and indistinct.

Color: Pallid greenish white; elytra somewhat milky with two slender oblique lines on clavus parallel to claval suture on the corium. The first and longest lying in the cell between sectors of the inner vein, second and third in the adjacent cells; fourth in the outer ante-apical and apical cells.

Genitalia: Last ventral segment of female rather short; hind border roughly toothed, pygofer rather long, bristled near the tip. Male valve rounded behind, plates short about half as long as pygofer; borders curved; a few bristles near margin; pygofers tapered, strongly bristled

23 specimens,,7 females and 16 males collected at Los Amates, Guatemala, Jan 17, 1905, by Professor J. S. Hine.

Phlepsius costomaculatus Van. D.

Allygus costomaculatus Van Duzee, Bull Buffalo Soc Nat Hist, V. 207.

Three specimens • Puerto Barrios, Mazatenango, Feb. 3d. It has been known heretofore from Texas and Florida.

Acinopterus acuminatus Van D.

Three specimens taken at Los Amates in January and February.

REMOVAL OF THE SHOWY PARTS OF FLOWERS AS AFFECTING FRUIT AND SEED PRODUCTION.

ARTHUR H MCCRAY

OBJECT OF EXPERIMENT.

In this experiment it was attempted to determine the effect of the cutting away and removing entirely of the showy parts of blossoms, on the production of fruit and its consequent seed. As will be seen in the great majority of cases, these showy parts will be also enveloping parts, covering, especially in early period of blooming the stamens and pistils and thus affording more or less protection from the elements, to these essential parts of the flower. Those who are familiar with the works of Chas. Darwin, will remember that he devoted much time and study to the pollination of flowers and that he embodied the results of his studies in a book entitled: "Cross and Self-Fertilization in the Vegetable Kingdom." One of these extended experiments was the exclusion of insects from flowers by covering with a netting. All flowers so excluded from insect visits, failed to set fruit. And so it was thought that by removing the large attractive parts of flowers, that insects would perhaps pass such by and hence no fruit would be produced. The experiments recorded below were carried out during the spring and summer of 1907.

These parts were easily removed by use of either a knife blade pressing it down upon the base of petal or whatever the part might be, and forcing it by a quick stroke from its place, or by a small pair of very fine pointed scissors. In either case care was taken not to unduly injure by mutilation any of the essential parts of the flower.

METHOD OF CONDUCTING THE EXPERIMENT.

This experiment is made up of a series of tests, which will be mentioned separately. By way of explanation when using the term test, test limb or test group, is meant that such a branch or group of blossoms has had the showy parts of the flowers removed, while by a check is meant a branch or group adjoining the test limb or group with blossoms untouched, but simply marked for comparison with the test.

WEATHER CONDITIONS AS A FACTOR.

Inasmuch as the weather conditions have been a prominent factor in important developments in this experiment from beginning to end, mention will be made of this in the separate tests.

PART PLAYED BY INSECTS.

As intimated, in the beginning of the experiment it was thought that insects would perhaps fail to reach those blossoms having the showy parts removed as considerable stress has been laid by various observers upon the present high development of flowers as to color and varied form, as due largely if not exclusively to insect visits. While as before mentioned the experiment has had to do with removal of showy parts, it must not be forgotton that these may also be protective. Too much stress has certainly been put upon such development of flowers as due to insect visits, and it will be shown that the visitation of insects of various orders is just as abundant after removal of the showy parts as before. In all of the tests made out of doors in the early part of spring very decided differences in amount of fruit setting was secured in check and test limbs. Thus on some test limbs there would be less than half as much fruit set as on the adjoining check limb on which the blossoms were left untouched. But we would not be justified in saying that this lack of fruit was due to lack of insect visitation when we know that insects were flying and when we see them on those flowers having the corollas removed. Thus on June 9, observations were made on a syringia bush which was visited quite early in the morning before any insects were flying and a large number of flowers were deprived of corollas. By the time this was finished insects began to come in abundance, among them being the common hive bee, many species of the smaller Apidae, Diptera, and Wasps. The visits were as frequent apparently on the flower with corollas removed as on the blossoms with all the parts. In the afternoon the bush was again visited and found that the flowers with corollas removed were still attracting insect visitors as they were in the early morning hours, the smaller apidae being quite noticeable.

Some of the more important of the separate tests will now be given somewhat more in detail.

Test I. May 1. Old apple tree in prime of bearing age, just beginning to open blossoms. Number of blossoms on test limb, 86. Number of blossoms on check limb, 88. Very cool day and no insects working. May 5, warmer and insects working. May 16, found on test limb, 31 young fruits, some of them dried and just ready to fall, while on the check limb adjoining, 55 fruits, most of them plump and growing. This makes the percentage of fruit setting 62 5% for the check limb, while on the test limb with corollas removed only 36.04%.

Test II. May 8. Wild Crab Apple Tree. Blossoms pink. Corollas removed with fine pointed scissors. Test limb of 304 blossoms. Check limb of 200 blossoms. These blossoms were not yet fully opened but were still partly enveloping the stamens and pistils On May 29, found on the check limb 140 fruits out of the original 200, while an the test with corollas removed there were only 145 out of the original 304, making the percentages 70% for the check and 47.6% for the test.

On June 4, this was again visited and found on check 35 plump fruits and on test only 7, 17.5% for check and 2 3% for test with corollas removed.

Test III May 9. Crab apple tree, near preceding test tree Test limb of 71 blossoms. Check limb of 72 blossoms. Flowers not opened, but parts enveloped by corollas Observations were made on May 21, May 29, May 30 and June 4. Frost morning of 28th of May. On June 4 on check limb there were seven fruits while on test only one, or 9.8% of fruit has set on the check limb with corollas untouched while on the test limb with corollas removed 1.4%.

Test IV. Nasturtiums in the green-house. A large number of flowers were secured for this test, there being three groups, a middle group used for a check with corollas untouched and on either side a second and third group from which the corollas were kept removed. In these green house flowers no difference was observed in test and check groups, fruit setting in as great abundance on the group with corollas removed as on those flowers with corollas left intact.

The results of more tests could be given to show the same lessening of the number of fruits setting on the groups of flowers with corollas or other showy parts removed. From this we see that a failure to set fruit on such flowers thus deprived cannot be attributed to lack of insect visitations.

WHY A FAILURE TO SET FRUIT?

As may be surmised from what has previously been said of the weather conditions as playing a part in the final results of the experiment, it may be said that it is this factor that has played so prominent a part, in that the flower has been deprived of a

protection against the elements, rather than a signal inviting insect visitations.

On the other hand there may be a reaction from the injury in removing the parts even though the vital parts, the stamens and pistils, remain untouched. Yet it is seen that the nasturtiums in the green house were unaffected by removing the showy parts, seeming not to suffer in the least, so with some cucumber vines in the green house, these set fruit without apparent check from cutting away these parts. This would lead us to think that injury from cutting away these parts is perhaps a minor consideration, although more tests would need to be made using for instance nasturtiums and cucumbers outside as an additional check, also several other kinds of flowers. At any rate the one thing of which there can be no mistake in interpreting is that insects are not necessarily attracted by the color of the flower parts, as has so often been said.

DISTRIBUTION OF THE WOODY PLANTS OF OHIO.

Geo W Hood

In the following list an attempt has been made to divide the woody plants of Ohio into groups according to distribution. The data were obtained from the State Herbarium which is now fairly complete as regards the woody plants of the State of Ohio. In some cases, further collecting is necessary to show the exact distribution. The plants are grouped according to the section in which they are found, as trees, shrubs, climbing vines, and trailing plants, under the heads of general, northern, southern, eastern, or rare distribution. There are apparently no woody plants that have come into the state from the west.

Out of the 278 species listed there are 106 trees, 54 shrubs, 13 climbing vines, and 4 trailing plants of general distribution; 11 trees, 11 shrubs, and 2 climbing vines, of northern distribution; 10 trees, 1 shrub, and 2 climbing vines, of southern distribution; 1 tree of eastern distribution; 21 trees, 36 shrubs, 4 climbing vines and 2 trailing plants of rare distribution. Besides the 278 species there are 32 others which have been reported as occuring in the state, 17 of which should probably be removed from the state list, but the remaining 15 should probably be retained as a part of the Ohio flora.

Supplementing the list on distribution is one of 66 of the important timber trees of the state, 54 of which are of general distribution and 12 of rare distribution. The 50 most important are marked with a star.

GENERAL DISTRIBUTION.

Trees

Juniperus virginiana L.
Populus alba L.
" balsamifera candicans (Ait.) Gr.
" deltoides Marsh.
" dilatata Ait.
" grandidentata Mx.
" tremuloides Mx.
Salix alba L.
" alba vitellina (L.) Koch.
" fluviatilis Nutt.
" discolor Muhl
" fragilis L
" nigra Marsh.
" nigra falcata (Pursh.) Torr
" purpurea L
Juglans cinerea L.
" nigra L.
Hicoria alba (L.) Britt.
" glabra (Mill) Britt
" laciniosa (Mx. f.) Sarg
" minima (Marsh.) Britt
" microcarpa (Nutt.) Britt.
" ovata (Mill) Britt.
Carpinus caroliniana Walt.
Ostrya virginiana (Mill.) Willd.
Betula lenta L.
Alnus incana (L) Willd.
" rugosa (DuR.) Koch.
Fagus americana Sw.
Castanea dentata (Marsh) Borkh.
Quercus acuminata (Mx.) Houd.
" alba L.
" coccinea Wang.
" imbricaria Mx.
" macrocarpa Mx.
" palustris DuR.
" platanoides (Lam.) Sudw.
" prinus L.
" rubra L.
" velutina Lam.
Ulmus americana L.
" fulva Mx.
" racemosa Thom.
Celtis occidentalis L.
Morus alba L.
" rubra L.
Toxylon pomiferum Raf.
Magnolia acuminata L.
Liriodendron tulipifera L.
Asimina triloba (L.) Dun.
Sassafras sassafras (L.) Karst.
Hamamelis virginiana L.
Plantanus occidentalis L.
Pyrus communis L.
Malus angustifolia (Ait.) Mx.
" coronaria (L) Mill.
" malus (L.) Britt.
Amelanchier botryapium (L. f.)DC.
" canadensis (L.)Medic.
Crataegus coccinea L.
" macracantha Lodd.
" mollis (T &G) Scheele.
" punctata Jacq
" punctata canescens Britt.
" tomentosa L.
" crus-galli L.
Prunus americana Marsh
" avium L.
" cerasus L
" serotina Ehrh.
" virginiana L
Amygdalus persica L.
Cercis canadensis L.
Gleditsia triacanthos L
Gymnocladus dioica (L) Koch
Robinia pseudacacia L.
Xanthoxylum americanum Mill
Ptelea trifoliata L.
Ailanthus glandulosa Desf.
Rhus glabra L.
" hirta (L) Sudw
" copallina L
" vernix L
Euonymus atropurpureus Jacq.
Staphylea trifoliata L.
Acer negundo L
" nigrum Mx.
" rubrum L.
" saccharinum L.
" saccharum Marsh.
Aesculus glabra Willd.
Tilia americana L.
Kalmia latifolia L.
Oxydendrum arboreum (L.) DC.
Diospyros virginiana L.
Fraxinus americana L.
" lanceolata Borck.
" nigra Marsh.
" pennsylvanica Marsh.
" quadrangulata Mx.
Cornus florida L.
" alternifolia L. f.
" asperifolia Mx.
Nyssa sylvatica Marsh.
Viburnum lentago L.
" prunifolium L.

Shrubs.

Taxus canadensis Marsh.
Salix humilis Marsh.
" sericea Marsh.
Corylus americana Walt.
Betula pumila L.
Berberis vulgaris L.
Hydrangea arborescens L.
Ribes aureum Pursh
" cynosbati L.
" floridum L'Her
Opulaster opulifolius (L) Ktz.
Spiraea salicifolia L
" tomentosa L
Rubus hispidus L.
" nigrobaccus Bail
" canadensis L
" americanus (Pers) Britt.
" occidentalis L
" strigosus Mx
" odoratus L.
Rosa blanda Ait
" carolina L.
" humilis Marsh
" lucida Ehrh
" rubiginosa L
" setigera Mx
Aronia arbutifolia (L) Medic.
" nigra (Willd.) Britt.
Rhus aromatica Ait
Ilex verticillata (L.) Gr.
Rhamnus lanceolata Pursh.
Ceanothus americanus L.
Hypericum prolificum L.
Dirca palustris L.
Gaylussacia resinosa (Ait) T. & G.
Vaccinium pennsylvanicum Lam.
" corymbosum L.
" vacillans Kalm
Polycodium stamineum (L) Greene
Oxycoccus macrocarpus (Ait.) Pers.
Ligustrum vulgare L
Cornus amomum Mill
" candidissima Marsh
" stolonifera Mx
Cephalanthus occidentalis L
Sambucus canadensis L
" pubens Mx.
Viburnum acerifolium L.
" cassinoides L.
" dentatum L
Symphoricarpos pauciflorus(Robb) Britt.
" racemosus. Mx
" symphoricarpos (L) MacM.
Lonicera tartarica L.

Climbing Vines.

Smilax hispida Muhl.
" rotundifolia L
Lonicera glaucescens Rydb.
Menispermum canadense L.
Celastrus scadens. L.
Vitis aestivalis Mx
" bicolor LeConte.
Vitis cordifolia Mx.
" labrusca L. (Northern).
" vulpina L.
Lycium vulgare (Ait f.) Dun
Tecoma radicans (L.) DC.
Parthenocissus quinquefolia (L.) Planch.

Trailing Plants.

Rubus procumbens Muhl.
Epigaea repens L.
Gaultheria procumbens L
Euonymus obovatus Nutt.

NORTHERN DISTRIBUTION.

Trees.

Pinus strobus L.
Larix laricina (DuR.) Koch.
Juniperus communis L.
Populus heterophylla L.
Salix amygdaloides And.
" bebbiana Sarg.
Salix lucida Muhl.
Betula lutea Mx. f.
Crataegus oxyacantha L.
Prunus pennsylvanica L. f.
Acer spicatum Lam.

Shrubs.

Comptonia peregrina (L.) Coult.
Ribes oxyacanthoides L.
" rubrum L.
Hypericum kalmianum L.
Lepargyraea canadensis (L.)Greene.
Chamaedaphne calyculata (L.) Moench.
Viburnum opulus L.
" pubescens (Ait.) Pursh.
" alnifolium Marsh.
Lonicera ciliata Muhl.
Diervilla diervilla (L.) MacM.

Climbing Vines.

Lonicera sempervirens L. Smilax bona-nox L.

SOUTHERN DISTRIBUTION.

Trees.

Pinus rigida Mill.
" virginiana Mill.
Betula nigra L.
Quercus minor (Marsh.) Sarg.
" marylandica Moench.
Liquidambar styraciflua L.
Rhamnus caroliniana Walt
Aesculus octanadra Marsh.
Tilia heterophylla Vent.
Chionanthus virginica L.

Shrubs.

Ascyrum multicaule Mx.

Climbing Vines.

Bignonia crucigera L. Smilax glauca Walt.

EASTERN DISTRIBUTION.

Trees.

Tsuga canadensis (L.) Carr.

RARE DISTRIBUTION.

Trees.

Pinus echinata Mill. Auglaize Co., probably accidental.
Thuja occidentalis L. Champaign, Franklin, Green, Highland and Adams Counties.
Populus balsamifera L. Auglaize, Harrison, Fayette and Ashtabula Counties.
Salix babylonica L. Ashtabula, Wayne, and Fairfield Counties.
" discolor eriocephala (Mx.) And. Erie and Licking Counties
" interior wheeleri. Rowlee. Erie and Preble Counties
" pentandra L. Franklin and Belmont Counties
Quercus prinoides Willd. Stark County.
Amelanchier rotundifolia (Mx.) Roem. Ottawa, Erie, Lorain and Highland Counties.
Crataegus rotundifolia (Ehrh.) Borck. Summit County.
Prunus mahaleb. L. Lake and Franklin Counties.
Robinia viscosa Vent. Cuyahoga, Lake, Ashtabula and Fairfield Counties.
Ilex opaca Ait. Lawrence County.
Cotinus cotinus (L.). Jefferson County. Escaped Cult
Euonymus europaeus L. Lake County. Prob. Escaped Cult
Rhododendron maximum L. Fairfield County.
Fraxinus biltmoreana Bead. Franklin and Erie Counties
Catalpa catalpa (L.) Karst. Champaign, Montgomery and Franklin Counties.
" speciosa. Warder. Ashtabula, Franklin, Hocking, Preble and Madison Counties. Cultivated extensively.
Sorbus aucuparia L. Lake County. Probably escaped Cult.
" sambucifolia (C. & S.) Roem. Crawford and Ashtabula Counties.

Shrubs.

Salix adenophylla Hook. Erie County.
" candida Fluegge. Erie and Wyandot Counties.
" cordata angustata (Pursh.) And. Ashtabula, Summit, Delaware, Franklin and Allen Counties.
" glaucophylla Bebb. Williams, Wyandot, Licking and Erie Counties.
" myrtilloides L. Portage, Wayne, Licking and Perry Counties.
" petiolaris Sm. Fulton, Woods and Erie Counties.
" petiolaris gracilis And. Erie County.
" humilis tristis (Ait.) Griggs. Madison and Athens County.

Philadelphus coronarius L. Erie, Monroe, Belmont, Jefferson and Auglaize Counties.
Ribes uva-crispa L. Franklin and Lawrence Counties. Escaped from Cult.
Spiraea prunifolia Sieb. Cuyahoga County. Escaped from Cult.
Sorbaria sorbifolia (L.) A. Br. Lake and Harrison Counties.
Rubus canadensis L. Montgomery, Franklin and Hocking Counties.
" phoenicolasius Max. Lake County.
Rosa canina L. Huron, Fayette and Brown Counties.
" gallica L. Lake County.
" nitida Willd. Lake County. Probably escaped from Cult.
Aronia atropurpurea Britt. Licking County.
Cotoneaster pyracantha (L.) Spach. Franklin County.
Prunus pumila L. Erie County.
Amorpha fruticosa L. Lucas County.
Robinia hispida L. Columbiana County. Probably Cult.
Euonymus americanus L. Clarke County.
Rhamnus alnifolia L'Her. Champaign, Cuyahoga and Lake Counties.
" cathartica L. Champaign and Greene Counties.
Ceanothus ovatus Desf. Ottawa and Erie Counties
Azalea lutea L. Fairfield County.
" nudiflora L. Geauga and Portage Counties.
Andromeda polifolia L Wayne, Stark and Geauga Counties.
Arctostaphylos uva-ursi (L.) Spreng Erie County.
Vaccinium atrococcum (Gr.) Heller. Williams County.
" canadense Rich. Lucas and Stark Counties.
Syringa vulgaris L Lake and Jefferson Counties.
Cornus circinata L'Her. Cuyahoga, Summit and Warren Counties.
Viburnum lantana L. Lake County Prob. escaped Cult.
" molle Mx Hocking and Adams Counties.

Climbing Vines

Lonicera xylosteum L. Lake County.
" hirsuta Eaton. Ottowa, Monroe and Lorain Counties.
" oblongata (Goldie). Hook Cuyahoga County.
" dioica L. Champaign and Franklin Counties.

Trailing Plants.

Berberis aquifolia Pursh. Lake County.
Chiogenes hispidula (L) T & G. Summit and Stark Counties

PLANTS NOT REPRESENTED, VERY DOUBTFUL.

Salix alba coerulea (Sm) Koch.
Betula populifolia Marsh
Philadelphus inodorus L.
" grandiflorus Willd.
Ribes lacustre (Pers.) Poir.
Spiraea corymbosa Raf.
Rubus baileyanus Britt.
" setosus Bigel.
" frondosus Bigel.
Prunus cuneata Raf
Acer pennsylvanicum L.
Ledum groenlandicum Oeder.
Kalmia augustifolia L.
Vaccinium pallidum Ait.
Oxycoccus oxycoccus (L.) Mac. M.
Myrica cerifera L
Quercus texana Buckley.

PROBABLY IN OHIO.

Corylus rostrata Ait.
Castanea pumila (L.) Mill.
Quercus Schneckii Britt.
" nana (Marsh.) Sarg.
" alexanderi Britt.
Ribes nigrum L. Escaped Cult.
Rosa cinnamomea L. Escaped Cult
Cornus baileyi Coult. & Evans.
Azalea viscosa L.
Gaylussacia frondosa (L.) T. & G.
Broussonetia papyrifera (L.) Vent.
Lonicera caprifolium L.
Smilax pseudo-china L.
Ampelopsis cordata Mx.
Parthenocissus quinquefolia laciniata Planch.

THE VALUABLE TIMBER TREES OF OHIO.

General.

*Juniperus virginiana L.
Populus balsimifera candicans (Ait.) Gr.
* " deltoides. Marsh.
" grandidentata Mx
*Juglans cinerea L.
* " nigra L.
*Hicoria alba (L.) Britt.
* " glabra (Mill.) Britt.
* " laciniosa (Mx.f.) Sarg
* " minima (Marsh) Britt.
* " microcarpa (Nutt.) Britt.
* " ovata (Mill.) Britt.
Carpinus caroliniana Walt.
Ostrya virginiana (Mill.) Willd.
*Betula lenta L.
*Fagus americana Sw.
*Castanea dentata (Marsh.) Borkh.
*Quercus acuminata (Mx.) Houd.
* " alba L.
* " coccinea Wang
* " imbricaria Mx
* " macrocarpa Mx.
* " palustris DuR.
* " plantanoides (Lam.) Sudw.
* " prinus L.
* " rubra L.
* " velutina Lam.
*Ulmus americana L.
" fulva Mx.
* " racemosa Thom.
*Celtis occidentalis L.
Morus rubra L.
*Toxylon pomiferum Raf.
Magnolia acuminata L.
*Liriodendron tulipifera L.
*Platanus occidentalis L.
*Prunus serotina Ehrh.
*Gleditsia triacanthos L.
*Gymnocladus dioica (L.) Koch.
*Robinia pseudacacia L.
*Acer nigrum Mx.
* " rubrum L.
* " saccharinum L.
* " saccharum Marsh.
Aesculus glabra Willd.
*Tilia americana L.
Diospyros virginiana L.
*Fraxinus americana L.
* " lanceolata Borck.
* " nigra Marsh.
* " pennsylvanica Marsh.
* " quadrangulata Mx
Cornus florida L
*Nyssa sylvatica Marsh.

Rare or Local.

*Pinus strobus L.
" virginiana Mill
*Larix laricina (DuR.) Koch.
*Tsuga canadensis (L.) Carr.
Populus heterophylla L.
" balsamifera L.
*Betula lutea Mx. f.
Quercus minor (Marsh.) Sarg.
Liquidambar styraciflua L
Aesculus octandra Marsh
*Tilia heterophylla Vent
*Catalpa speciosa Warder.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, December 7, 1908.

The club was called to order by the President and the minutes of the previous meeting were read and approved as read.

The President appointed as a committee to consider a change in the time of monthly meeting the following: Professors F. L. Landacre, R. F. Griggs, and Mr Arthur L. Smith.

The following names proposed at the last meeting were elected to membership: Lionel King, Malcolm Dickey, J. L. Paxton and S. C. Kelton.

Professor Lnadacre's paper on the Origin of Cranial Ganglia of the Cat Fish, occupied the evening. In discussing this question Professor Landacre called attention particularly to the functional point of view in interpreting the cranial ganglia as contrasted with the strictly morphological point of view. From the functional point of view there are several well defined systems variously distributed throughout the cranial nerves in such a manner as to best conserve the functional needs of the organism. These are not symmetrically distributed either in the trunks of a single metameric nerve or among the various metameric nerves. But these systems can be reduced to a simple type such as that found in a spinal nerve although in the head this simple type becomes greatly modified.

The obejct of the work undertaken upon Ameiurus was to determine the exact mode of origin of these diverse elements of the cranial nerves. The following brief outline will suffice to show the principal facts brought out in the discussion: (a) The general cutaneous nerve ganglia are derived in Ameiurus from the lateral mass (neural crest of other types); (b) The acustico-lateralis nerves supplying the ear and lateral line organs are less homogenous in their mode of origin.

The lateris ganglia of the VIIth nerve come from the lateral mass. The VIIIth ganglion comes apparently exclusively from the auditory vesicle. The lateralis IXth comes from the auditory vesicle. The lateralis Xth comes from the post auditory placode.

The close relationship of this system to the general cutaneous is shown in the mode of origin of the lateralis VIIth.

(c) The general communis ganglia come from the lateral mass. The special cummunis or gustatory come from the epibranchial placodes.

The ganglia from which the cranial trunks and roots arise show quite as much discreetness in their mode of origin as they do in their function and distribution both central and peripheral.

After a discussion of the paper the club was adjourned.

ARTHUR H. MCCRAY, Secy.

ORTON HALL, Jan. 18, 1909.

The club was called to order by the President, Miss Freda Detmers, and the minutes of the previous meeting were read and approved as read.

The program consisted of Reports from those present at the Baltimore Meeting, December, 1908, of the American Association for the Advancement of Science and Affiilated Socities. Prof. Osborn stated that this was probably the largest aggregation of scientific men ever gathered in the country.. Prof. Osborn reported on the meetings of the American Association of Economic Entomologists mentioning Prof. S. A. Forbes' address in which a line of work was presented which will put entomology on a wider biological basis. Of the papers given before the Entomological Society of America, he mentioned in particular that of Prof. Poulton of Oxford, England, on Mimicry in American butterflies.

Prof. Prosser gave an extended account of the geology section laying particular emphasis upon the proper recognition which Paleontology is being given in stratigraphical work.

Prof. Lazenby reported on the Darwin celebration

Prof. Griggs stated that while in the Botany section, papers of fundamental importance were read no great stride in science was in evidence. The work consisted of a large number of papers of real though not striking scientific value.

Dr. G. D. Hubbard described the papers on geographic and physiographic work as a series of smaller contributions to the greater problems.

Mr. Herbert Osborn, Jr., gave a report of the three views of evolution as brought out at the meetings· (1) Davenport supports the theory of mutation as a predominating factor of evolution; (2) Eiganmann, of Indiana, supports the theory of the inheritance of acquired characters; (3) H. F. Osborn in his study of paleontology supports the theory of evolution by small variations.

Messrs. J. F. Zimmer and L. L. Scott gave brief reports.

Prof. Griggs, the chairman of the committee to consider a change in the time of meeting, reported that in the judgment of the committee no other night of the week seemed any more desirable than the present time, viz.: the first Monday of each month. A motion was made and carried to the effect that action on the report of the committee be laid on the table until the next meeting.

Wilbur Mikesell was elected to membership.

ARTHUR H. MCCRAY, Secy

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TABLE OF CONTENTS.

NOTES ON THE EMBRYOLOGY OF THE CARYOPHYLLACEAE

MEL. T. COOK.

Some years ago the writer undertook a comparative study of the morphology of several species belonging to the family Caryophyllaceae and related families for the purpose of demonstrating the constancy or variability of these internal characters and thus reaching some conclusions as to their value in phylogenetic studies. In connection with this work two brief papers were published* at that time. A change of location and lines of work necessitated the discontinuance of this line of study and the writer has not had an opportunity to take it up again. However, it has been thought desirable to offer these accumulated notes.

The Vaccaria vaccaria (L.) Britton was collected by Mr. H. H. York near Greencastle, Indiana, in 1903. It is an European species which has become rather widely distributed throughout the country.

The Silene conoidea L.† was collected on the Agricultural Experiment Station farm at Newark, Delaware. Only two specimens were found and the seed of these were supposed to have been introduced in Alfalfa from some of the Rocky Mountain States. However, it proved to be a south European species and it may have been introduced through an entirely different source. It was collected primarily for class study, since the embryos of members of this family are especially good for class work.

*The development of the embryo sac and embryo of Claytonia virginica, OHIO NATURALIST, Vol. III, No. 3, pp. 349–353, 1905. The development of the embryo sac and embryo of Agrostemma githago, OHIO NATURALIST, Vol. III, No. 4, pp. 365–369, 1905.

† Determined by Dr. J. N. Rose, National Museum, Washington, D. C.

The most striking characters noted in the study of the Agrostemma githago referred to above were (a) the formation of an inner and an outer nucellar zone, (b) the growth of the nucellus so as to leave the embryo sac deeply embedded, (c) the formation of a nucellar beak which projects through the micropyle, and (d) a filamentous embryo with the large basal cell.

Since the publication of the above paper, L. S. Gibbs has published a paper on "Notes on the Development and Structure of the Seed in Alisnoideae"‡ in which the characters were very similar to A. githago. The development of the embryo sac was the same, also the two zones, which are referred to as nucellar layers, and the beak like projection of the nucellus through the micropyle which is somewhat more pointed than in A. githago and is referred to as a papilla. There is no lateral pouch-like enlargement of the sac as in A. githago. The development of the embryo is practically the same.

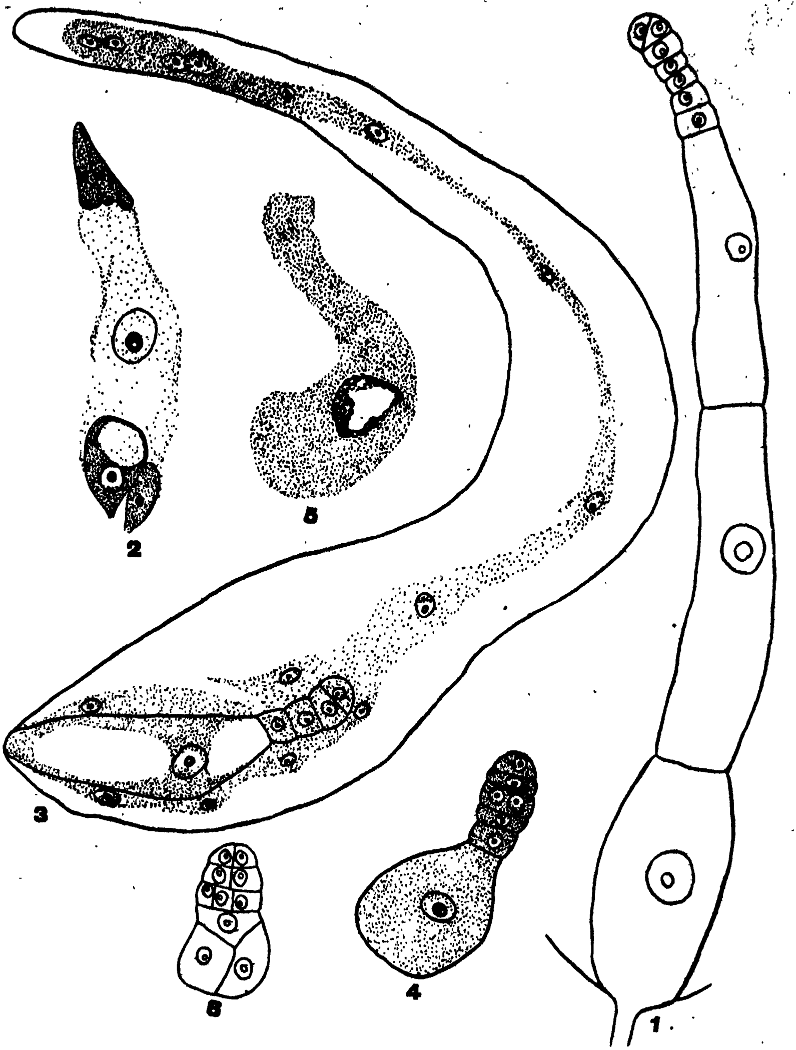
No attempt was made to trace the early history of the embryo sacs in either species. In both species the two nucellar zones and the beak were very evident; the sacs are located deep in the nucellus but there was no pronounced lateral enlargement as in the case of A. githago although in some instances there was a slight enlargement of this kind. In both species the embryos were filamentous in their early stages and possess the large basal cells.

In V. vaccaria the embryo was exceptionally long (Fig. 1), the length being due to the excessive length of the three lower cells. The basal cell becomes very large, stains readily and has very much the appearance of the corresponding cell in A. githago. It is also directly connected with the passage through which the pollen tube entered and which is now filled with protoplasm. Gibbs says that in Stellaria this basal cell is "elongated so much that it forms a haustorium at the micropolar end, which projects beyond the embryo sac into the nucellar tissue." Gibbs also says that "the nucellus is very large and active in appearance, and the cell suggests an absorbent organ."

In Silene conoidea the embryo is not so long as in V. vaccaria but is almost identical in development with A. githago (Fig. 3). However, instead of the cell next to the apical cell being the first to divide, it is usually the second from the apical cell (Fig. 4). The large basal cell eventually disentegrates (Fig. 5) and the further history of the embryo is practically the same as in A. githago. In one instance an abnormal embryo (Fig. 6) was observed.

The endosperm in both species was non-cellular (Fig. 3) and identical with the endosperm in A. githago.

‡ Annals of Botany, Vol. XXI, pp. 25-55, 1907.



COOK on "Caryophyllaceae."

EXPLANATION OF PLATE XXII.

Fig. 1. Filamentous embryo of Vaccaria vaccaria.
Fig. 2. Eight nucleate embryo sac of Silene conoidea showing the egg, one symergid, two antipodals, and the endosperm nucleus.
Fig. 3. Embryo sac of S. conoidea with filamentous embryo and endosperm.
Fig. 4. Normal embryo of S. conoidea.
Fig. 5. Disintegration of the basal cell of the embryo of S. conoidea.
Fig. 6. Abnormal embryo of S. conoidea.

Agricultural Experiment Station, Newark, Delaware.

THE UNCULTIVATED FIBER PLANTS OF OHIO.

FREDA DETMERS.

This list of plants was taken from the Ninth Report of the United States Fiber Investigation Commission of the Department of Agriculture, 1897. They are grouped according to the part used and the character of the fiber as pseudo, structural and bast fibers. Many of these plants are used quite extensively in the arts in other countries if not in this one.

The list of uncultivated plants is supplemented by a few cultivated ones, some of which are in general cultivation as Zea mays, Triticum sativum, etc., and others as Linum usitatissimum have escaped from cultivation.

PSEUDO FIBERS.

FUNGI:—Polyporus squamosus Fr., P. betulinas Fr. and Merulius lacrymans Fr. are used for razor-strops; Fomes fomentarius Fr. is used for chest protectors, hat linings, coarse garments, tinder and other household purposes, Daedalea quercina Pk is used for tinder.

FILICALES:—Adiantum pedatum L—The glossy leaf stalks of this species and of A. capillus-veneris are used for ornamental weaving in caps, baskets and mats by the Northern Indians.

LYCOPODIALES.—Lycopodium clavatum L. is used in Sweden in the manufacture of door-mats.

GYMNOSPERMAE:—Pinus strobus L. is used for excelsior

MONOCOTYLAE:—Philotria canadensis (Mx) Britt. is used for paper, but is of doubtful utility; Sorghum vulgare Pers. is used for brooms and brushes.

DICOTYLAE:—Hicoria spp—Hickory splints are used for brushes; Ulmus fulva Michx.—The bark is used for horse collars, Dirca palustris L.—The leathery twigs are used as thongs; Fraxinus nigra Marsh.—Thin layers of wood are employed as material for baskets; Ligustrum vulgare L—The branches are used for bird cages and traps, Viburnum spp—The flexible and tenacious branches are used for binding bales and large packages.

TEXTILE FIBERS.

Structural Fibers.

GYMNOSPERMAE:—Larix larincina (Du Roi) Koch.—The roots are used by the Indians for sewing seams of birch bark canoes and making basket kettles.

MONOCOTYLAE:—Typha latifolia L. and T. angustifolia L.—The leaves are used for chair bottoms, mats, ropes and strings, and the fibrous material borne in the spadix is used for stuffing

pillows; Hordeum vulgare Bailey; Phragmites phragmites (L.) Karst.—The structural fiber is used in Mexico for mats to cover houses; Secale cereale L.; Spartina cynosuroides (L.) Willd.; Sporobolus cryptandrus (Torr.) A. Gr.—It is also used for paper; Triticum sativum Lam.; Zea mays L.—Also used in upholstery and for paper; Eleocharis palustris (L.) R. & S.; Scirpus lacustris L.; Eriophorum polystachyon L.—Also used for paper; Juncus effusus L.; Yucca filamentosa L.

DICOTYLAE:—Melilotus alba Desv.

Bast Fibers.

DICOTYLAE:—Populus deltoides Marsh; Salix spp.—Used also in the manufacture of willow ware; Morus rubra L.; Morus alba L.; Humulus lupulus L.—This is used also for paper; Cannabis sativa L.; Urtica dioica L.; Urtica gracilis Ait.; Urticastrum divaricatum Kuntze; Asimina triloba (L.) Dunal.—The inner bark stripped from the branches is used by fishermen to string fish and by Indians for withes, strings and nets; Camelina sativa (L.) Crantz; Robinia pseud-acacia L.—Used also for paper; Linum usitatissimum L.; Celastrus scandens L.; Tilia americana L.—Used as rough cordage and coarse woven mattings; Althaea officinalis L.; Althaea rosea Cav.; Malva sylvestris L.; Malva rotundifolia L.—These two species of Malva are very widely used; Abutilon abutilon (L.) Rusby.—The fiber is sold as a substitute for jute and the cellulose is used as paper stock; Hibiscus moscheutos L.; Chamnerion angustifolium (L.) Scop.; Apocynum cannabinum L.; Asclepias syriaca L.—The fiber is ranked between that of flax and hemp. The hairs from the seeds are used in this country in stuffing beds. In Russia 20% of Asclepias hairs mixed with 80% wool are manufactured into a cloth called silver cloth. Used alone the hairs are too smooth to weave; Asclepias incarnata L.—Used for all purposes to which hemp can be applied; Ambrosia trifida L.; Solidago canadensis L.; Helianthus annuus L.—Used also for rough wrapping paper; and Helianthus tuberosus L.

THE CONEMAUGH FORMATION IN SOUTHERN OHIO.[1]

D. DALE CONDIT.

INTRODUCTION.

During the summer of 1907, the writer was engaged by the Geological Survey of Ohio in tracing and mapping the Pittsburg and Pomeroy coals in southern Ohio. The seams were traced from the Ohio River in Lawrence County northeastward across Gallia, Meigs, Athens and into Morgan County. This field work gave the writer an extensive acquaintance with the Conemaugh as far down the section as the Cambridge limestone and is the basis of this paper.

NOMENCLATURE OF THE FORMATION.

The term Conemaugh was first applied by Franklin Platt,[2] in 1875, to his so-called "Middle Barren Measures" and "Mahoning sandstone." Later the name was used in Maryland[3] to designate all the rocks between the base of the Pittsburg coal and the top of the Upper Freeport coal. With these limits, the name is today in general use throughout the Appalachian Basin. In 1901, Charles S. Prosser[4] adopted for Ohio the formation names Allegheny, Conemaugh, Monongahela and Dunkard of the Maryland Survey in place of Lower Productive, Lower Barren, Upper Productive and Upper Barren Coal Measures as adopted by Dr. Orton from Rogers' classification in Pennsylvania.

Generally, the Allegheny, Conemaugh, Monongahela and Dunkard are ranked as formations, but Dr. I. C. White, in his reports on the Coal Measures of West Virginia[5], prefers to consider these as series.

GENERAL DESCRIPTION.

The thickness of the Conemaugh in southern Ohio is usually 325 to 375 feet which is little more than half the thickness found along the northern outcrop in Pennsylvania.[6] A shaft at Canaanville, Athens County, shows the interval between the Pittsburg and Middle Kittanning coals to be 436 feet.[7] Although the base of the Conemaugh can not be conclusively located in this shaft section, it is probable that the formation is here less than 375 feet thick. The following general section shows the prin-

1. Published by permission of J. A. Bownocker, State Geologist.
2. Sec. Geol. Surv. Pa., H. p. 8.
3. O'Harra: Maryland Geol. Surv. Allegany County, 1900, p. 86–118, and Prosser: Jour., Geology, Vol. IX, 1901, p. 426.
4. Am. Jour. Sci. 4th Ser. Vol. XI, March, 1901, p. 199.
5. West Virginia Geol. Surv. 1908, Vol. IIa, p. 622, and Geol. Surv. Ohio, 4th Ser., Bull. 7, p. 11.
6. J. J. Stevenson, Carboniferous of the Appalachian Basin, p. 346.
7. Geol. Surv. Ohio, 4th Ser., Bull. 9, p. 212. Depth of shaft should read 442 ft. instead of 412 ft.

cipal horizons as seen in southern Ohio. The succession in descending order is:

PITTSBURG COAL	Ft.	In.
Clay	3	
Pittsburg limestone	4	
Shales, sandy	45	
Sandstone, massive	35	
Coal blossom		
Limestone, nodular	0	8
Shales, sandy	50	
Shales, "Big Red," nodular ore and limestone	25	
Shale	5	
AMES LIMESTONE, fossiliferous	1	8
Coal blossom		
Shale	10	
Shale, "Pittsburg Red"	40	
Ewing limestone	0	6
Shale	5	
PATRIOT LIMESTONE, fossiliferous	0	6
Shale, black	3	
Patriot coal	1	6
Shale	15	
Sandstone, "First Cow Run"	25	
Shale	10	
UPPER CAMBRIDGE LIMESTONE, fossiliferous	2	
Coal, thin	0	6
Shale	5	
LOWER CAMBRIDGE LIMESTONE, fossiliferous	1	0
Coal, thin		
Upper Mahoning sandstone	12	
Brush Creek Coal	1	
Clay	2	
Mahoning standsone, often shaly	50	
Clay, with iron ore	0	7
Shale	3	
UPPER FREEPORT COAL.		

The Pittsburg limestone lies from 2 to 20 feet below the Pittsburg coal. It is white or grayish in color and contains a few minute fossils. In southern Athens County a thickness of over 15 feet is attained but farther south 3 feet is uncommon.

The massive sandstone, the base of which lies about 90 feet below the Pittsburg coal, is probably the equivalent of the "Mitchell"[8] oil sand near Marietta. Sections in the Pan Handle

8. Geol. Surv. Ohio, Vol. VIII, Bull. I, p. 30.

area of West Virginia show a heavy sandstone known as the Connelsville,[9] with a base about 110 feet below the Pittsburg coal. It is possible that the sandstone under discussion belongs to this horizon. This rock is very conspicuous along the Hocking River Valley east from Athens, where an unusual thickening brings it up close to the base of the Pittsburg coal.

Below the sandstone is a coal blossom underlain by a few inches of nodular limestone. This horizon was frequently crossed in five different counties, but workable coal was found at only one place near the head of Shade River, in Athens County.

The succeeding portion down to the Ames limestone is rather variable, consisting of variegated shales with occasional thinbedded sandstones. A short distance above the Ames, however, there is often a red clay which thickens much in some localities. It is known to oil drillers as the "Big Red." When weathered, there results a sticky red gumbo which lends a ruddy aspect to the country roads of Gallia, Meigs and other counties

The Ames limestone receives its name from a village in Ames Township, Athens County, where the rock is well exposed in numerous outcrops. The interval between the Ames and the Pittsburg coal is about 150 feet, although it may run as low as 130 or as high as 175 feet. The limestone is seldom over 30 inches thick. From place to place, a great variation in composition and appearance is noticed. In Rutland Township, Meigs County, the Ames horizon is represented by 10 to 15 feet of calcareous shale with imbedded fossiliferous limestone nodules In the same township the bed changes to a calcareous, fossiliferous, sandstone overlain by a ferruginous chert. Careful search across Mason and Windsor Townships in Lawrence County failed to reveal any trace of the Ames, but it was found outcropping in its proper place at Burlington, Union Township, in the southern part of the County.

Beneath the Ames there is often a coal blossom This is wanting in many places and is not known to be of workable thickness anywhere.

Some ten feet below the Ames occur variegated green, bluish and red shales with zones of hematite ore and nodular limestone. These shales are found everywhere by the oil driller and are known as the "Pittsburg Reds."

The next persistent horizon is the Patriot lying about halfway between the Ames and Cambridge. It consists of a thin, nodular, fossiliferous limestone underlain by coal.

Lovejoy[10] has given the name "Patriot" to the coal. If the practice of applying the same name to more than one member of

9. W. Va. Geol. Surv., County Rep'ts and Maps, Ohio, Brooke and Hancock Counties, 1906, p. 113.

10. Geol. Surv. Ohio, Vol. VI, p. 631.

a formation be permissible, then the term Patriot would be very appropriate for the limestone also, and is proposed. The coal is persistent across entire counties with a thickness of about 18 inches. At several points along Leading Creek in Rutland Township, Meigs County, a workable thickness is found.

The "First Cow Run" sandstone is massive and coarse-grained and contains conglomerate zones. At Burlington, in southern Lawrence County, the river bluffs show an exposure of over 60 feet. This is unusually thick, an average being about 25 feet.

The Cambridge limestone lies from 240 to 300 feet below the Pittsburg coal and from 90 to 145 feet below the Ames limestone. In typical outcrops it is a gray rock forming a single bed about 28 inches thick. The stone is very hard and when struck gives a metallic ring. In places there is a double structure consisting of two beds of limestone interlain by several feet of shale containing a thin coal. Toward the south both beds are often cherty.

Below the Cambridge, a thin coal is often found. This is especially true in the southern counties. Here it sometimes reaches a thickness of 3 feet.

The Brush Creek or No. VIIa coal is of little importance in southern Ohio. It is usually represented by little more than a blossom.

The Mahoning sandstone is frequently shaly and does not show the persistent characteristics of the same horizon in Pennsylvania.

Economic Features.

The few coal seams of the Conemaugh are too thin to be worked except in a very small way. Occasionally a local thickening gives a deposit which is stripped by the farmers for home use. Of these thin coal seams, the Patriot is probably the most persistent.

Limestone and iron ore deposits are very scant. Nowhere is there a limestone thick enough to play any part in the cement industry. The few thin outcrops are stripped by the farmers for use on the roads. The Ames and Cambridge are well suited for this purpose, being very hard and durable. The clays contain numerous zones of hematite nodules, but the deposits are too thin and scattered to be of any importance.

Beautiful laminated sandstones are not unknown in the formation but most of these are too friable for building purposes. Some of the more resistant rock is used for bridge abutments and foundations.

Most of the Conemaugh belt is not well adapted to agricultural purposes. The topography is very broken especially in the counties bordering on the Ohio River. The more resistant sandstone layers form abrupt ledges, while the thick beds of soft shale

are easily cut through by the streams. As a result there are numerous gorge-like valleys with narrow flood plains. The steep shale hills are much given to landslides. This unstable state of affairs makes much of the country of little use except for grazing purposes.

Although the preceding statements would seem to indicate that the Conemaugh is "barren" as its old name suggests, still there are certain redeeming features. The area was once covered with valuable forests and could be reforested In addition it contains an inexhaustible supply of clay shale and is also an oil producer.

Formerly the region was clothed with unbroken forests of oak, tulip, walnut and other valuable timber. Very little of this former growth remains. In its place one finds large tracts of land overgrown with sumach, sassafras and blackberry bushes. It is a question whether it would not be well to convert such land into a forest reserve.

There is an unending supply of shale suitable for the manufacture of the rougher wares. At Athens, the shale of the Ames horizon is utilized in the making of an excellent grade of paving brick. At a few points, the clay below the Pittsburg coal becomes of economic importance, but at present it is not developed in the southern part of the state.

Two sandstone horizons have been demonstrated to be oil reservoirs, namely the massive sandstone with a base 90 feet below the Pittsburg coal and the "First Cow Run" sandstone lying above the Cambridge limestone. The former is not of great importance. A few pay wells in it have been put down near Marietta. The "First Cow Run" sand serves as a reservoir for the Chesterhill field[11] located in the adjoining corners of Athens, Morgan and Washington Counties. This field is ranked among the important oil territories of the state. It has been a producer since 1860. A narrow oil belt extends eastward from the Chesterhill field to the Ohio River in the vicinity of Marietta.

The Cambridge and Ames Limestones.

The Cambridge and Ames limestones are valuable guides to the geologist, lying as they do in a section made up of a featureless monotony of shales and sandstone. There are certain lithological peculiarities about the two limestones by which one may be distinguished from the other by a person familiar with the two.

In addition to the lithological peculiarities it is probable that a study of the fauna of each horizon will reveal more striking differences. Although the writer has collected material from only a few places, yet a study of these fossils seems to warrant this inference.

Collecting was done in the Cambridge at Northup, Gallia County and at Langsville, Meigs County, twenty miles to the

11. Geol. Surv. Ohio, 4th Ser., Bull. I, pp. 126–139.

north. The Ames was visited at Carpenter, Meigs County, and at the shale quarry of The Athens Paving Brick Co., in the town of Athens.

Section of The Athens Brick Company's Quarry:

	Ft.	In.
Sandstone	5	
Shale	30	
AMES LIMESTONE	1	10
Shales, blue and red	35	
PATRIOT LIMESTONE	0	10
Shale, black, fossiliferous		

In the above section the Ames limestone is a single layer with numerous vertical divisions which cause the stone to come from the cliff in angular blocks. This is quite different from the Ames at Carpenter where it is shaly. The Patriot is a yellowish, nodular rock, cherty in places but highly fossiliferous. Large specimens of *Productus semireticulatus* and *Spirifer cameratus* are common. The underlying black shale is thickly spotted with *Chonetes verneuilanus* in all stages of growth from very small to large robust indviduals.

List of fossils identified from the Ames limestone:

Productus cora D'Orbigny.
Productus costatus Sowerby.
Productus semireticulatus Martin.
Productus pertenuis ? Meek.
Spirifer cameratus Norton.
Chonetes granulifer Owen.
Ambocœlia planoconvexa Shumard.
Spiriferina kentuckyensis Shumard.
Lophophyllum profundum ? Milne-Edwards & Haime.
Petalodus destructor Newberry & Worthen.

List of Cambridge fossils:

Spirifer cameratus Norton.
Reticularia perplexa McChesney.
Spiriferina kentuckyensis Shumard.
Productus costatus Sowerby.
Productus cora D'Orbigny.
Productus punctatus Martin.
Productus semireticulatus Martin.
Derbya crassa Meek & Hayden.
Chonetes verneuilanus Norwood & Pratten.
Seminula subtilita Hall & Clarke.
Aviculopecten coxanus Meek & Worthen.
Lingula sp.
Pernopecten aviculatus Swallow.
Edmondia glabra Meek.
Phillipsia major Shumard.

An inspection of the preceding lists shows that many species are common to both horizons but there are certain noteworthy exceptions. *Ambocœlia planoconvexa* is abundant in the Ames but was not found in the Cambridge. *Chonetes granulifer* is so abundant as to form almost solid masses in the Ames but was not discovered in the Cambridge. On the other hand, *Chonetes verneuilanus* is extremely abundant in the Cambridge, while no specimens were found in the Ames *Seminula subtilita* also common in the Cambridge, was not discovered in the Ames. Other species found only in the Cambridge are: *Reticularia perplexa*, *Productus punctatus*, *Derbya crassa*, *Aviculopecten carboniferus*, *Aviculopecten coxanus*, *Macrodon tenuistriata*, *Pernopecten aviculatus* and *Edmondia glabra*. No great importance is attached to this last list as only a few specimens of each species were found. Further search may reveal most of them in the Ames also.

Whether these faunal differences are representative of general widespread conditions or are only local variations in faunal distribution can only be determined by extensive collecting and thorough study. It is noteworthy, however, that faunal conditions are almost identical at the two collecting points in the Cambridge separated by a distance of more than twenty miles.

G P. Grimsley, in his report on the Pan Handle district of West Virginia[12], gives a list of fossils from the Ames limestone near Morgantown, as identified by Dr J. W Beede, of Indiana University. This list includes *Ambocœlia planoconvexa* and *Chonetes granulifer*, so abundant in the Ames but not found in the Cambridge where the writer collected Furthermore, the several species mentioned as occurring in the Cambridge limestone where visited, but wanting in the Ames, are also wanting in the Ames list of Morgantown, West Virginia, with the exception of *Derbya crassa* and *Aviculopecten carboniferus*.

The occurrence and non-occurrence of the above fossils in the Ames limestone at Athens, Ohio, and Morgantown, West Virginia, is probably more than a mere coincidence. It seems to indicate parallel faunal conditions at the time of deposition of the limestone, in the two rather widely separated regions

12 W. Va Geol. Surv County Rept, 1906, p 127

Ohio State University

THE CLASSIFICATION OF PLANTS, V.

JOHN H. SCHAFFNER.

In a previous paper the entire plant kingdom was classified into seven fundamental divisions or subkingdoms, representing the great successive stages in the evolution of plants as a whole. These groups do not show genetic relationships but simply steps in the upward evolutionary motion. But there is a principle of segregation operative in the organic kingdom as well as one of progression. The whole plant kingdom thus comes to be a series of greater and smaller divergent lines or branches. In a group of nonsexual organisms every line of descent is a single line which diverges from another line at a definite point, but in a sexual group, where interbreeding goes on freely, there is an interaction throughout the whole mass and the scheme of descent resembles an elongated net with greater and smaller meshes. The whole progressive network of descent of a group may, however, also be represented by a line. When individuals or groups of individuals arise which become sterile to other members of the general group a new line is segregated, so that for the larger groups the diagram of descent must be quite similar whether of sexual or nonsexual forms, even though the diagram for individuals is fundamentally different in the two cases.

As a convenient guide to memory, the scheme of relationships may be represented graphically by a tree with greater and smaller branches. Every branch thus recognized, whether large or small, is characterized by some peculiarity which remains dominant in all of the individuals and groups of the branch. Or in other words, as Bessey* has said: "Every phylum is the result of a development which differs from that which preceded it because of the incoming of a new dominant idea." The number of great branches or phyla recognized depends somewhat on the views of the particular systematist making the classification. It is not always easy to distinguish fundamental genetic characters from those which are merely progressive, and may be developed in various unrelated groups. Among the characters which do not represent genetic relationships, when considered by themselves, but which have been developed independently in various lines may be mentioned the following: Origin of sexuality, differentiation of gametes, passage from a unicellular to a filamentous condition, differentiation of the filament with base and apex, loss of chlorophyll with development of parasitism and saprophytism, development of unisexual gametophytes, loss of sexuality, origin of heterospory, development of complex leaf

* BESSEY, CHARLES E. The Phyletic Idea in Taxonomy. Science N. S. 29: 91–100, 1909.

forms, development of woody stems, development of the annual habit, development of epigyny, development of cyclic flowers, coalescence of the perianth or of other organs, decrease in the number of floral parts, development of zygomorphy, increase or decrease in the number of ovules, the presence of alternate and opposite leaves, development of geophily, development of the various kinds of fruits, extra-floral nectaries, and a host of other important or trivial characters both morphological and physiological.

In the present attempt sixteen great phyla have been recognized. Recently Bessey† has published a paper entitled "A Synopsis of Plant Phyla" in which fifteen phyla are proposed. In general it may be stated that the writer agrees with Bessey's scheme and as far as possible his names have been adopted in the present paper The sixteen phyla are as follows

SCHIZOPHYTA	MYCOPHYTA
MYXOPHYTA	BRYOPHYTA
DIATOMEAE	PTENOPHYTA
CONJUGATAE	CALAMOPHYTA
GONIDIOPHYTA	LEPIDOPHYTA
PHAEOPHYTA	CYCADOPHYTA
RHODOPHYTA	STROBILOPHYTA
CHAREAE	ANTHOPHYTA

It will be seen that a uniform system of group endings is maintained except for three phyla each of which is represented by a single class. At present the writer is not prepared to give these groups distinctive names, although uniformity would have its advantages.

Although the Diatomeae and Conjugatae are commonly united as one phylum, there are fundamental differences between them which have not been cleared up satisfactorily and until further knowledge of their cytology is obtained a final union is not advisable. The fifth phylum, the Gonidiophyta (goné, generation and dim. term. idion, gonidium, a zoospore) includes all the green algae except the Conjugatae and Chareae, besides two classes of fungi, the Archimycetae and Monoblepharideae. The name, Archimycetae, should more properly be spelled Archaemycetae or simply with an e. This group connects with the lower green algae while the Monoblepharideae are closely related to the Siphoneae. Almost all of the Gonidiophyta, as the name indicates, are characterized by the presence of zoospores. The Chareae have practically nothing in common with the red algae. Their affinities are probably with the green algae but so far removed that they are here regarded as an isolated phylum.

† Univ. Studies 7: 275–373. 1907.

In the Mycophyta are included not only the higher fungi but also the Zygomycetae and Oomycetae. These two classes may have affinities with the Siphoneae in the Gonidiophyta but their exact relationships with these plants appear obscure at present and the gap is as great if not greater than that which separates them from the lower Ascomycetae. The Laboulbenieae may belong with the Rhodophyta.

For Bessey's "Pteridophyta" a new name, Ptenophyta (ptenós, feathered) is used, for the reason that "Pteridophyta" has become too well established as a term of much wider application in which sense it will still be needed when the phyletic scheme of classification is adopted. The Gneteae, which consist of three very distinct families, Tumboaceae, Ephedraceae, and Gnetaceae, are considered to be modified Strobilophyta, the same tendencies showing here as are to be discovered in several lines of the Anthophyta. The Ephedraceae are no doubt a distinct order, the other two families showing some relationships to each other.

The phyla with their classes and approximate number of species, may be characterized as follows:

1. **Schizophyta.** Fission Plants. 2,400 species.

Nonsexual, unicellular or filamentous fission plants of simple structure, with or without chlorophyll but never with a pure chlorophyll-green color

Cyanophyceae.
Schizomycetae.
Myxoschizomycetae.

2. **Myxophyta.** Slime Moulds. 400 species.

Nonsexual unicellular plants without chlorophyll, having a plasmodium of more or less completely fused amoeboid cells and usually building up complex sporangium-like resting bodies.

Myxomycetae.

3 **Diatomeae.** Diatoms. 3,000 species.

Brownish-green unicellular or unbranched filamentous algae with diatomin and silicified cell walls consisting of two valves, and with or without a conjugation of the cells.

Diatomeae.

4. **Conjugatae.** 1,200 species.

Unicellular, or unbranched, filamentous, green algae without silicified cell walls, with zygospores produced by the conjugation of the cells.

Conjugatae.

5. **Gonidiophyta.** 2,000 species.

Unicellular, filamentous, or thalloid, sexual or nonsexual, plants, green in color or without chlorophyll, nearly all producing

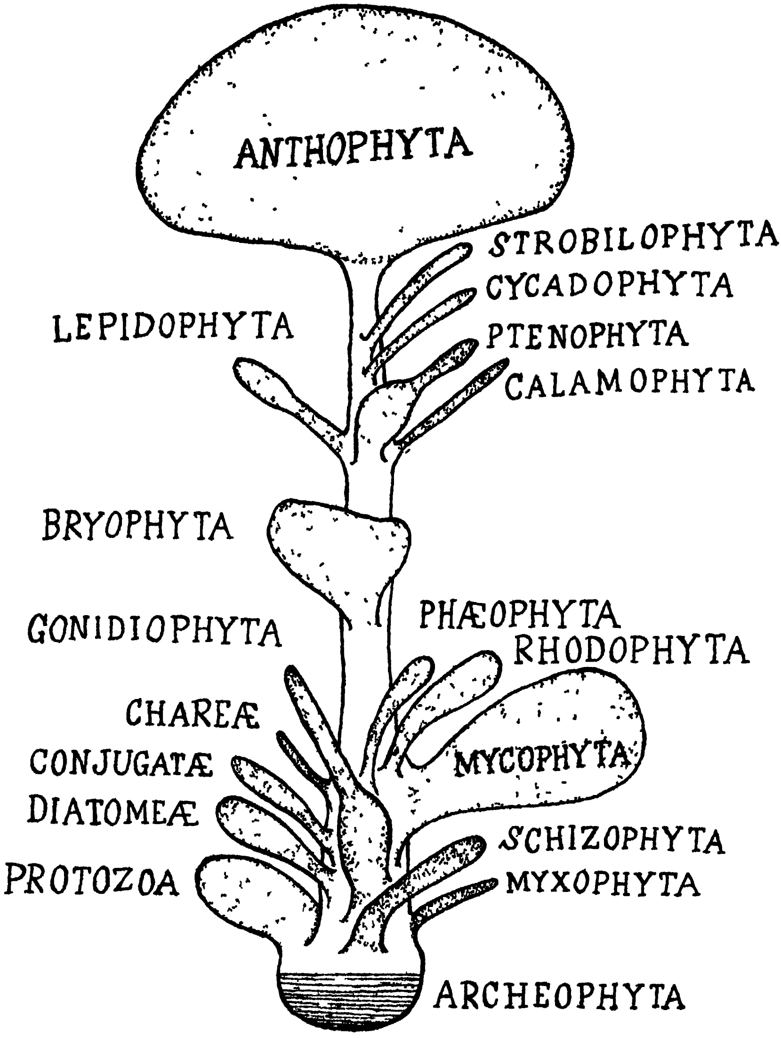


Diagram of the Plant Phyla.

nonsexual zoospores, the sexual forms having true isogamous or heterogamous gametes.

Pleurococceae.
Archimycetae.
Protococceae.
Hydrodictyeae.
Monoblepharideae.
Siphoneae.
Conferveae.

6. **Phaeophyta.** Brown Algae. 1,000 species.

Mostly marine algae with chlorophyll and phycophaein and with gametes, both isogamous and heterogamous, which are all discharged from the gametangia.

Phaeosporeae.
Cyclosporeae.
Dictyoteae.

7. **Rhodophyta.** Red Algae, 2,000 species.

Mostly marine algae with chlorophyll and phycoerythrin, having nonciliated sperms and stationary eggs.

Bangieae
Florideae.

8 **Chareae.** Stoneworts. 160 species.

Filamentous, aquatic, green algae with globular antheridia containing sperm-bearing filaments, the sperms being biciliate; nonsexual spores absent.

Chareae.

9 **Mycophyta.** 47,000 species.

Plants with a septate or nonseptate mycelium, destitute of chlorophyll, with or without sexuality but never with typical gametes.

Zygomycetae
Oomycetae.
Ascomycetae.
Laboulbenieae, 500 species.
Teliosporeae.
Basidiomycetae.

10 **Bryophyta.** 17,000 species.

Nonvascular plants with a definite alternation of generations, the egg produced in an archegonium, and the sporophyte permanently parasitic on the gametophyte.

Hepaticae.
Sphagneae.
Andreaeae.
Musci.
Anthocerotes.

11. **Ptenophyta.** 4,500 species.

Vascular seedless plants with comparatively large multiciliate sperms and usually with large, commonly compound leaves, the sporophylls not in cones.

Filices.
Hydropterides.
Isoeteae.

12. **Calamophyta.** 25 species.

Vascular seedless plants with jointed stems and small whorled leaves, with comparatively large multiciliate sperms, and with the sporophylls in cones.

Equiseteae.
Sphenophylleae.
Calamarieae.

13. **Lepidophyta.** 660 species.

Vascular seedless plants with simple, usually small leaves covering the stem, with small biciliate sperms, and with the sporophylls in cones or sometimes forming zones alternating with the sterile leaves.

Lycopodieae.
Selaginelleae.

14. **Cycadophyta.** 90 species.

Seed plants with open carpels permitting the pollengrains to fall into the micropyle, ovules with pollenchambers, sperms multiciliate.

Pteridospermae.
Cycadeae.
Cordaiteae.
Ginkgoeae.

15. **Strobilophyta.** 400 species.

Seed plants with nonmotile sperms, with open carpels and ovules without pollenchambers, and having the pollengrains falling upon the micropyle.

Coniferae.
Gneteae.

16. **Anthophyta.** Flowering Plants. 125,000 species.

Seed plants with closed carpels, with female gametophytes of eight or rarely sixteen cells, with nonmotile sperms, and having the pollen grains fall upon a stigma.

Monocotylae.
Dicotylae.

ON HIBERNATION IN THE RACCOON.

S. R. Williams

Some years ago, on the third of January, a young raccoon (Procyon lotor Storr) was taken during his winter sleep while a hollow sugar tree was being cut down in Butler County in Southwestern Ohio.

It is certain that the animal was really hibernating as the weather for more than two weeks before had been very cold, reaching twenty degrees below zero Fahrenheit. An opossum was found in the same woods that day frozen stiff. In the latitude of Ohio the Raccoon is said to hibernate for at least three months, even four when the winter is severe.

The animal had a few worn sticks in its stomach, together with a slight amount of liquid very like mucus. There was nothing at all in the small intestine, the walls of which very were thin and thrown in longitudinal folds so that the lumen of the intestine was almost obliterated. The inside of the intestine was clean and slightly pinkish in color. There was a small amount of dry fecal matter in the posterior end of the large intestine.

The major part of the fat on the body was definitely localized. The naked body without the skin weighed 3700 grams (see figure photographed from the front and right side). A sheet of fat was taken from the rump and upper hind quarters, which weighed 416 grams, or one-ninth of the total weight. This was more than half an inch in thickness just in front of the base of the tail and shows plainly on the hind quarters in the photograph. The mesentery, which is shown spread out, had on it 84 grams of

fat. 127 grams were removed from other portions of the body in pieces of varying size. The whole amounted to 627 grams or more than one-sixth of the weight of the body. In view of the presence of fat in thin sheets between the muscles and over them, a conservative estimate would be that the amount of fat stored for use during the winter's cessation from activities was more than one-fourth of the total weight of the animal.

In our common hog, which does not hibernate, the thickest layer of fat is likely to be over the shoulders—the most exposed portion.

It would be interesting to learn the conditions in other animals, such as the bear, which hibernate. In this case it is plain that as the raccoon curls up in the hollow tree with his nose between his hind legs and his tail over his head and shoulders, the rump and back make the less protected part of the circle. Hence the location of the heavy fat blanket in that region.

Miami University

Correction.—In the March, 1909, NATURALIST the poison ivy was inadvertently omitted from the list of woody plants of general distribution. Add Rhus radicans L. to the list of climbing vines on p. 471.

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TABLE OF CONTENTS.

NUCLEAR DIVISIONS IN THE POLLEN MOTHER-CELLS OF CONVALLARIA MAJALIS L.

LOUIS W. SAUER.

The significance which recent investigators have read into the two maturation divisions, as well as the peculiar behavior of the chromatic substance during and after synapsis, make the chromosome the cynosure of all the problems in heredity.

Although the Liliaceae have served as a classical group of angiosperms for this kind of work in botanical research, only twice have their closest allies, the Convallariaceae, received attention. Strasburger ('88) in a very general way, refers to the chromosomes of Convallaria, and Weigand ('99, '00) takes up the development of the microsporangium, and of the embryo sac of Convallaria, but little emphasis is laid on the nuclear divisions in the pollen mother-cells. Weigand holds that the reduced number of chromosomes is eighteen, that he could not determine the plane of the first nuclear division of the mother cell, and that the plane of the second division appears to be transverse. He further states that at several instances the chromatin behaves peculiarly, and that the generative cell of the pollen grain is cut off shortly before the flower opens.

The present writer undertook a careful study of the nuclear phenomena of the pollen mother-cells of Convallaria majalis L, with the hope of making further contribution towards the solution of the problem of heredity and the chromosome. With none of the above mentioned observations of Weigand does the present writer agree. This paper is offered as a preliminary to further work on the chromosome.

To Professor Guyer, at whose suggestion the work was undertaken, the writer is much indebted for valuable assistance.

MATERIAL AND METHODS.

Neubert's "Multibell" brand of German Lily-of-the-Valley pips were "forced" in moist sand, at the temperature of about 20 C., in a green-house, in subdued light. When the sprouting pips were of various lengths stamens were isolated from the flower buds. Pips two to four centimeters in length contained all the stages desired. After killing and fixing the anthers in a chrom-acetic acid solution* they were washed in tap-water, passed through the series of alcohols, and preserved in 85% alcohol. Paraffin (51° C.) sections (3-10u), stained on the slide, cleared in xylol, and mounted in balsam, were used for study. Longitudinal and transverse sections of anthers were made. As stains, Heidenhain's iron-alum-haematoxylin with Orange-G, and Delafield's haematoxylin with safranin gave good results. Drawings and observations are based on slides stained chiefly with the former combination. The pollen mother-cells near the apex of the anther are slightly more advanced than those nearer the filament.

OBSERVATIONS.

The nucleus enters a state of rest at the conclusion of the last archesporial division of the sporophyte tissue (Fig. 1). This is of short duration, however, and the chromatin matter soon becomes transformed into a number of fine, delicate threads in the form of a network (Fig. 2). The nucleolus is visible from the beginning, and it, as the cell becomes larger, behaves peculiarly (Figs. 1–8), in that it becomes larger, less chromatic, and shows a clear, vacuole-like area near its center. Occasionally it fragments into micronucleoli. With an increasing volume of the cells the chromatin matter of the nucleus becomes more conspicuously granular, and the linin appears to contract. There seems to be a reciprocal loss of chromatic substance from the nucleolus (Figs. 6, 7, 8). The clear area in the nucleolus makes it resemble in appearance an erythrocyte of man (Fig. 6a). Occasionally two such clear areas are noticeable in the nucleolus (Fig. 8). The cell increases in volume, the spirem continues to contract, and the continuity of the thread becomes more and more apparent (Figs. 3, 3a, 4, 5a).

From now until the apparent climax of the process which ends in synapsis, the contraction of the spireme thread is more rapid, and the network becomes more twisted. The linin is at all times of smaller diameter than the chromatin granules (Figs. 3a, 5a). The continuity of the twisted spireme thread becomes very apparent, and the thread becomes entirely separated from

*Chrom-acetic acid solution: Chromic acid 0.3g., glacial acetic acid 0.7cc., water 99cc.

the wall (Fig. 6). The chromatin granules are now quite uniform in size and shape, and the spireme exists as a single thread throughout its entire length (Figs. 6, 6b).

After synapsis a loosening or unwinding of the thread begins. The linin becomes thicker, the granules elongate, and the spireme becomes shorter, although it again occupies the whole of the nuclear cavity (Fig. 7). Then an apparent division of the granules takes place and a double row can be seen (Fig. 8a). Occasionally a part of the thread appears still single while the rest is double (Fig. 8a). This appearance would be the same if the granules were dividing or conjugating. The fact that the granules lying opposite each other are so much alike in size and shape is all that makes this appear to be a division of the thread. There is quite a marked decrease in chromatin matter, however, and this, at first sight, would favor a conjugation, but it must be remembered that the spireme is rapidly contracting (Figs. 7, 8, 9). After a short time this doubleness is no longer apparent. For the present this will be considered a temporary division of chromatin granules. In later studies the author intends to give this step more consideration.

With continued thickening the ribbon begins to show an arrangement into definite loops (Figs. 9, 10, 11), which later become sixteen chromosomes. Just how these are formed from the thirty-two of the spermatogonia has not yet been determined. They are of various shapes and sizes, but a common thickness. In fact, thickness seems to be the only factor which the sixteen chromosomes have in common. They are apparently twice as thick as the chromosomes of the sporophyte cell. Since the relative stage of development of chromosomes was found to govern thickness, it was thought advisable to compare for this purpose chromosomes of nearly the same stage. Figs. 17, 21, 26, show telophases of cells after the first reduction division, second reduction division, and sporophyte cell division, respectively. The fact that the daughter chromosomes of Fig. 17 are so much thicker than those of Fig. 26 seems to indicate that the phenomenon after synapsis might have been a pairing of granules.

There is, usually, one chromosome which is much longer than the others. In Fig. 13, it is the fourteenth chromosome. It shows a lobing at one end. Many of the chromosomes at this stage show a lobing at either, or both ends. (Fig. 12a). This lobing is either the beginning of the longitudinal division, or else it is a remnant of the double phenomenon noticed shortly after synapsis. The nucleolus now fragments and passes into the cytoplasm. With the ejection of the micronuclei radiations in the cytoplasm appear, and with their polarization the chromosomes assume a median position between the two centers of radiation. No centrosomes are present. This is the prophase of the first reduction division. Fig. 14 is a very late prophase or early metaphase.

THE FIRST NUCLEAR DIVISION OF THE MOTHER-CELL.

All sixteen chromosomes divide almost simultaneously. To determine the plane of this division was no easy task. That it is a transverse division is quite evident from the cells examined. Figs. 14a, 16a, 16b, show some chromosomes dividing transversely, and since this is the only transverse division, it should be considered qualitative. The spindle fibers end near or at the free ends of the chromosomes. The homologous daughter chromosomes show not only a marked correspondence in size, but also in shape (Fig. 14, 14a, 15, 16b). Whether this similarity in shape is inherent, or is the result of a stress brought about by the spindle fibers, or is the result of a repulsion of the daughter chromosomes has not been determined. J, I, V, U, shaped chromosomes are present. I and J shaped predominate (Figs. 15, 16). In rare instances indications of a median cleft throughout the length of the chromosome in metaphase could be noticed (Fig. 14a). This is probably the beginning of the second division. Since the daughter chromosomes show such a marked similarity in shape, the author was at first skeptical about the plane of the division, but enough data are now at hand to prove that the division is transverse. Figs. 14a, 14b, 15a, 16a, 16b, etc., show this. In the migration of the daughter chromosomes to their respective poles, a doubleness is occasionally detectible (Figs. 16, 17a). This is probably the beginning of the second division. A wall now develops and a distinct nuclear plate is seen between the daughter nuclei (Fig. 17). The micronuclei apparently re-enter the nucleus (Figs. 17, 18).

THE SECOND NUCLEAR DIVISION OF THE MOTHER-CELL.

The daughter nuclei do not enter into a definite period of rest, and the chromosomes soon become developed into the mother skein of the second division. The transition is so rapid, and the telophase of the first division and the prophase of the second are so close together, that the individual chromosomes seem to be separate from the beginning. Occasionally, a cell is seen in which the second division has already taken place, while its sister cell is still undivided (Fig. 22). Ordinarily, the sixteen chromosomes of each of the two daughter cells of the first division are almost immediately ready for the second division. Sometimes a cell is seen in which some chromosomes, the double nature of which is apparent, lie in a horizontal position in prophase, while other chromosomes, which are slightly more advanced, are at right angles to the horizontal ones, and are already migrating to their respective poles (Fig. 19). There seems to be little probability that this is a cell in which some chromosomes are dividing longitudinally while others are dividing transversely as McClung

('05) found in certain Orthoptera. Such a pronounced irregularity in appearance as shown in Fig. 19 is of comparatively rare occurrence.

In this division the spindle fibres are not nearly as prominent as in the first division. No centrosomes are present. The fragmented nucleolus, which was in the nucleus during the prophase, is again in the cytoplasm.

That the plane of division is longitudinal is evident (Figs. 19a, 20a). The line of cleavage seems to be that occasionally indicated earlier in the process (Figs. 14a, 16a, 19a, 20a). The homologous daughter chromosomes, as expected, show a marked similarity in shape and size (Figs. 19a, 20a). Although a great variety of shapes were seen the U and I shaped chromosomes predominated. (Figs. 20, 21).

The nuclear membrane disappears during late prophase (Fig. 14), is absent during metaphase and early telophase (Figs. 15, 16, 26), and again appears in late telophase (Fig. 17). It remains present during the subsequent stages (Figs. 18, 22, 23, 24, 25). The breaking down of the membrane is co-incident with the migration of the nucleolus into the cytoplasm as micronucleoli.

THE MICROSPORES.

After the late telophase of the second division (Fig. 21), the chromosomes of the daughter nuclei develop into irregular networks, and, with the appearance of a transverse wall, a cell is formed out of each of the two hemispheres, and thus the spore-tetrad is completed. The formation of the wall is, in Convallaria, as in most of the Monocotyledons, "successive," i. e., begun after the first division, and completed after the second. The young microspores are arranged bilaterally in the spore-tetrad (Fig. 23). Occasionally, as already said, a cell is found in which one of the cells has not yet divided, and then only three cells are enclosed by the wall (Fig. 22). Whether the undivided cell will ultimately divide, could not be determined.

Sometime after the common wall is completed, each microspore develops a delicate wall which seems to be independent of the former. This thin wall grows in thickness and later becomes differentiated into the intine and exine layers (Figs. 23, 24, 25). The tetrad then breaks, and the four microspores become free and separated. All this occurs long before the flower opens.

The next change that the nucleus undergoes is a division, whereby the generative cell is formed. The nucleus of this cell is at first chromatic and so deeply stained that its structure cannot be determined (Fig. 24). After a short time, however, the cell becomes differentiated by a distinct cell wall. Although the generative nucleus is at all times more chromatic than the nucleus from which it arises, its structure becomes discernable sometime before the flower opens. The generative nucleus usu-

ally contains several micronucleoli, and a network of chromatin matter (Fig. 25). The pellucid matter which surrounds the generative nucleus contains many minute granules and is probably the cytoplasm of the new cell. Convallaria agrees with most of the other Monocotyledons in the early separation of its generative cell. No sperm-nuclei could be found, and their formation doubtless takes place during the formation of the pollen-tube, and is, therefore, a part of fertilization, as it is in most of the Monocotyledons.

SUMMARY.

1. The continuous spireme up to and through synapsis is a single row of chromatin granules on a linin thread.
2. The chromatin granules seem to show a temporary division shortly after synapsis.
3. The spireme shortens and thickens, and breaks up into sixteen chromosomes.
4. The first division of the chromosomes in the microsporocyte is transverse, and, therefore, qualitative.
5. The homologous daughter chromosomes show marked similarity in size and shape.
6. The daughter chromosomes of the first division seem to represent the chromosomes of the second.
7. The second nuclear division is longitudinal, and therefore, equational.
8. The spore-tetrad breaks up into four incipient pollen-cells, in each of which a generative cell forms, quite a while before the flower opens.
9. The nucleolus fragments and passes into the cytoplasm just before or during the prophases of the two reduction divisions.
10. The nuclear membrane disappears during late prophase, is absent during metaphase and early telophase, is present in late telophase and remains during subsequent stages.
11. The chromosomes of the generative cells are thicker, but not longer than the chromosomes of the sporophyte cells.
12. The homologous daughter chromosomes of the second division also show a marked similarity in size and shape.

University of Cincinnati, Feb., 1909.

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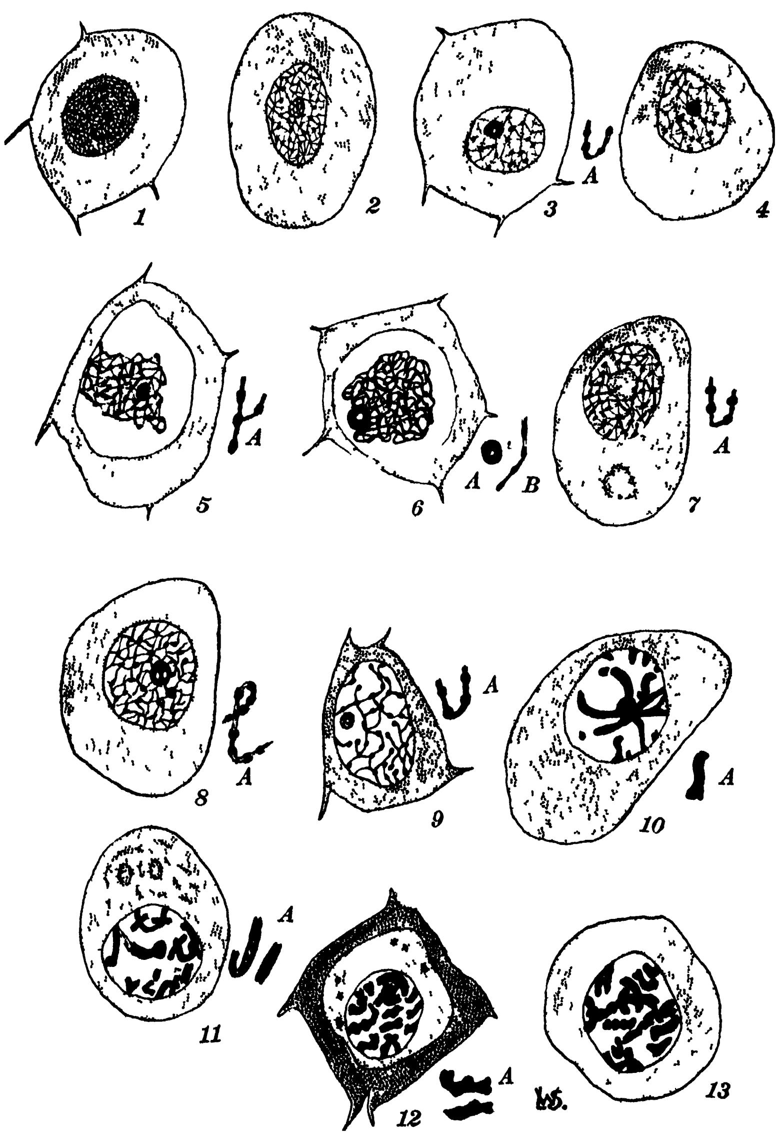
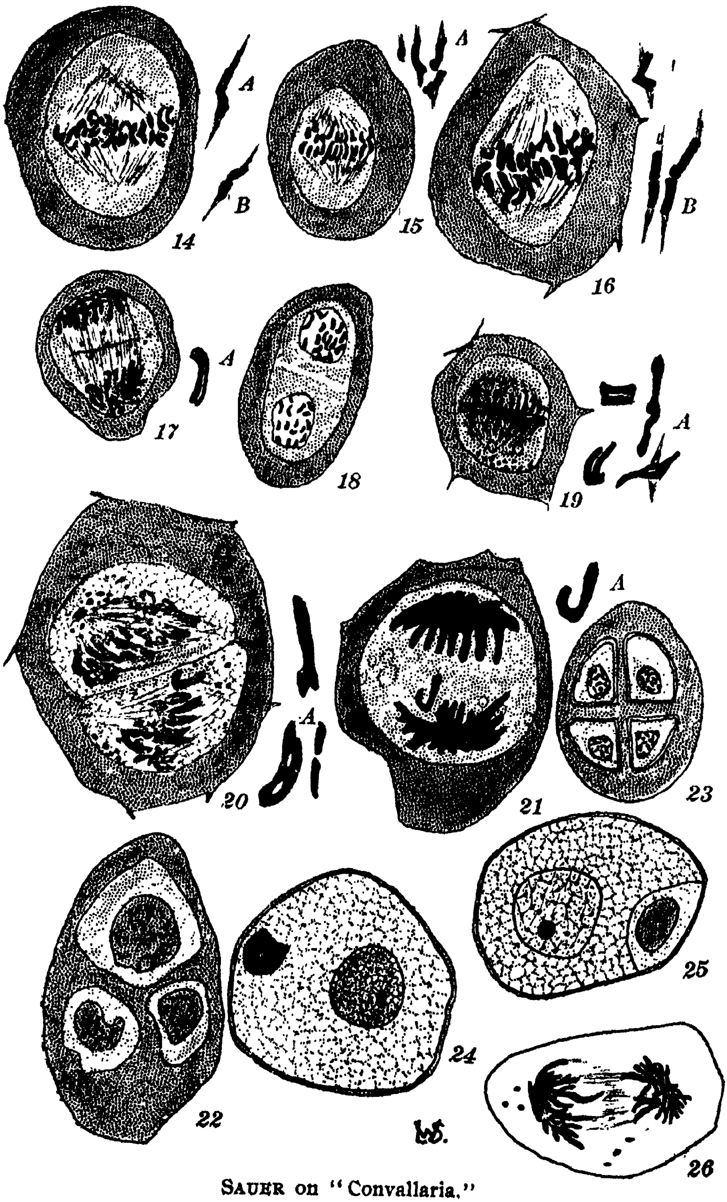


SAUER on "Convallaria."

OHIO NATURALIST. *Plate XXV.*



SAUER on "Convallaria."

EXPLANATION OF PLATES XXIV AND XXV.

All figures were made with the aid of a camera lucida. The figures representing entire cells (excepting Fig. 20) were studied with a B. & L. one-inch ocular and a 1-16 oil immersion objective; Fig. 20, and all sub figures (excepting 20a) with a Zeiss No. 12 ocular and Leitz 2 m. obj.; Fig. 20a with the No. 12 ocular and the 1-16 objective.

Fig. 1. Microsporocyte with a very dense network of chromatin matter; nucleolus visible, nuclear membrane distinct.

Fig. 2. Microsporocyte with chromatin fibrils and definite granules.

Fig. 3. Microsporocyte with thread contracting, the granules spherical, linin definite, nucleolus deeply stained. 3a. A part of the thread.

Fig. 4. More advanced stage; more granules noticeable.

Fig. 5. Early synapsis, nucleus occupies most of the cell. 5a. Granules are more oval.

Fig. 6. Synapsis, thread free and continuous. 6a. Nucleolus shows a clear area. 6b. Granules quite uniform in size, linin distinct.

Fig. 7. Nucleus smaller, nucleolus pale and irregular, chromatin matter contracting. 7a. A part of the thread.

Fig. 8. A later stage. 8a. The thread, some of the granules showing a doubleness.

Fig. 9. The contraction more advanced, the granules single, the nucleus somewhat larger. The nucleolus very pale. 9a. A part of the chromatin ribbon.

Fig. 10. A microsporocyte with loops nearly developed. The nucleolus apparently the center of activity. 10a. A separated, homogeneous band of chromatin matter.

Fig. 11. The chromosomes nearly formed. 11a. Chromosomes showing lobed ends and a differentiation down their median axes.

Fig. 12. The sixteen chromosomes formed, micronucleoli in the cytoplasm. 12a. Two chromosomes.

Fig. 13. A sporocyte showing sixteen chromosomes.

Fig. 14. Metaphase of first maturation division. 14a, 14b, chromosomes showing transverse divisions.

Fig. 15. Late metaphase. 15a. Chromosomes showing transverse divisions.

Fig. 16. Telophase of heterotype division. 16a. Chromosomes dividing.

Fig. 17. Telophase of heterotype division, micronucleoli, wall, plate, etc. 17a. A chromosome with lobed ends.

Fig. 18. Late telophase, the resting chromosomes smaller than in 17.

Fig. 19. Metaphase of second division. Median split more noticeable. 19a. Chromosomes dividing.

Fig. 20. Metaphase of the homotype division, the mitoses simultaneous in the two daughter cells of the first division. 20a. Chromosomes.

Fig. 21. Telophase of second division, chromosomes homogeneous, no lobed ends. 21a. A chromosome.

Fig. 22. A tetrad, the upper cell has not yet undergone a homogeneous division.

Fig. 23. A spore-tetrad with common wall around the four cells.

Fig. 24. An incipient pollen-grain. The dark body is the generative nucleus.

Fig. 25. Mature pollen-grain, generative cell with its clear cytoplasm at margin of the pollen-grain.

Fig. 26. Telophase of a sporophyte division, showing long chromosomes, nucleoli scattered in the cytoplasm.

CHROMOSOME DIFFERENCE IN ASCARIS MEGALOCEPHALA.*

JOHN H SCHAFFNER.

While studying at the University of Zürich, in the winter of 1907-8, I spent some time working over a number of my old Ascaris slides in order to compare the peculiarities of the chromosomes with those of Agave virginica. The developing eggs showed the four chromosomes to consist of two sizes easily distinguishable and a number of drawings were made at the time. The work on Agave and other plants, however, prevented me from following the matter further. In the meantime Montgomery[1] has published a paper showing the same results as my own observations. I wish, therefore, to present this confirmatory note on his very interesting report.

I found that in the first two cleavage divisions, the chromosomes appeared as two longer and two shorter bodies. Montgomery[2] had previously (in 1904) concluded that the chromosomes of the polar spindles as well as of the first cleavage showed a difference in size, that the egg furnished one larger and one smaller chromosome, that the sperm cell also contained one larger and one smaller chromosome, and that the pairs can be distinguished in the first cleavage. Griggs[3] has also shown that there is a difference in the shape and behavior of the two loops on the reduction spindle of the egg. (Note his figures 5, 6, 7, 9, 10 and 11, which were however, not very satisfactorily reproduced in the printed paper.)

My drawings were taken at random, and in some representing older stages the difference is not so marked. The difference is best seen shortly after the segmentation of the spirem, before the extreme contraction has taken place. The difference in length and shape is plainly shown in figures 1, 2, 3, 5 and 7. The drawings are, of course, projections and the real difference is shown to a greater or lesser extent depending on the angle from which the chromosomes are seen. Figure 1 is a spirem of the second cleavage and shows the relative positions of the two longer and the two shorter chromosomes. The spirem has just broken at one point while two other constrictions are visible.

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* Contributions from the Botanical Laboratory of the Ohio State University, XLIV.

1. MONTGOMERY, JR., THOMAS H. On Morphological Difference of the Chromosomes of Ascaris megalocephala. Archiv für Zellforschung, Bd. 2, Heft, 1, pp. 66-75. 1908.

2. MONTGOMERY, JR., T. H. Some Observations and Considerations upon the Maturation Phenomena of the Germ Cells. Biological Bull. 6:137.

3. GRIGGS, ROBERT F. A Reducing Division in Ascaris. Ohio Nat. 6: 519-527. 1906.

This figure shows that there has been no pairing so far of the maternal and paternal chromosomes. This would seem to indicate that definite pairing is delayed until the prophase of the reduction division where it must take place before or at the time of the formation of the spirem. The two shorter chromosomes are situated at the ends of the long ones which form a more or less parallel pair. This arrangement can still be noticed shortly after the segmentation of the spirem and is sometimes quite striking. It is shown to some extent in figures 2, 3 and 5.

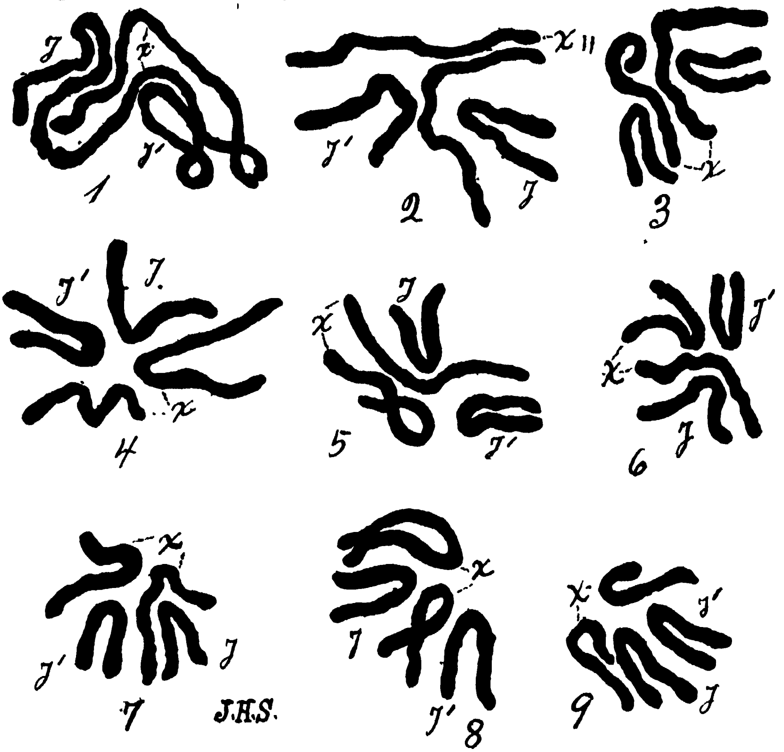
There is a rather constant difference between the pair of smaller chromosomes, one of which is now known to be a maternal and one a paternal chromosome. It would be interesting if the pedigree of these two bodies could be determined. The writer has frequently pointed out this difference in appearance between the two smaller chromosomes in Ascaris. It was, therefore, a pleasure to read Montgomery's statement of the same fact. It is evident that even though the difference is slight, it is distinct enough to be clearly seen by two observers entirely independent of each other and is not a matter of the imagination. I have always described (orally) the one chromosome as being more U-shaped or rounded at the head and the other as more pointed, V-shaped, or narrowed at the apex. Montgomery describes the difference as follows: "The smallest chromosome of all is very frequently hook-shaped and the other of the smaller pair often U-shaped, while the longer ones have usually two or three angles each, but none of these differences in form appear to be constant." By long-continued study one might perhaps be able to acquire the ability to distinguish these bodies just as an expert systematist can readily determine two closely related species at sight which look exactly alike to the inexperienced. Thus we are led to hope that a plant or animal may be found which will present constant and recognizable differences between the maternal and paternal chromosomes.

In my work on Agave[4], a marked individuality was found in the twelve reduction chromosome loops as regards morphological character. The statement was also made that "Since these are bivalent chromosomes, it is evident that on the theory of the conjugation of maternal and paternal chromosomes, the conjugating pairs must be quite similar in shape and activity. In the microsporocytes the bivalent chromosomes have an individual shape and size easily distinguishable."

It is not necessary to assume, at the present time, that no interchange whatever of material takes place between the chromosomes even though we ascribe definite individuality to them. There might occasionally or even regularly be some

4. SCHAFFNER, JOHN H. The Reduction Division in the Microsporocytes of Agave virginica. Bot. Gaz. 47: 198-214. 1909.

interchange of the granular chromatin and the individual shape (probably dependent on the linin structure) still be retained. The chromatin granules appear to become diffused and spread out no less than the linin, to be massed together again at definite stages in the ontogeny.



All the figures are from accurate Abbé camera lucida drawings on the same scale. Fig 1. Spirem of second cleavage just at the time of the separation of the chromosomes. The spirem is already broken at one point. The position of the two long and two short chromosomes is clearly marked, showing that the chromosomes are not yet paired. Figs. 2–9. Pole views of equatorial plates of first and second cleavage.

Then again it is even possible, with all of our present knowledge, that the chromatin acts as a unit organism and produces periodically a definite number of chromosomes of rather definite size and form without localizing any given quantity of the substance in any definite part. There is no need to insist that a viscid plasm must comport itself like a set of wooden blocks as some would have us believe. However, I think that most of the evidence so far presented points to a material individuality of the linin groundwork of the chromosome.

THE CATALPA LEAF SPOT.*

J. B. PARKER.

On October 11, 1908, the writer collected from a catalpa tree growing upon the campus of Ohio State University, a number of leaves affected by the leaf spot fungus so prevalent upon this tree. A few of these spots bearing fruiting bodies thought at the time of collection to be those of a species of Phyllosticta were killed and hardened in alcohol preparatory to imbedding in paraffin. While yet in the alcohol this material was examined under the low power of the microscope which revealed upon some of these spots fruiting bodies smaller and lighter in color than those of Phyllosticta, which were present also upon other spots. When sectioned and stained these smaller bodies proved to be perithecia containing 8-spored asci in various stages of development. This discovery led to a more careful study of the remainder of the material collected and to a comparison of this with specimens of leaf spot fungi of the catalpa found in the herbarium of the late Dr. W. A. Kellerman. As a result of this study, the writer is of the opinion that the fungus is a new species belonging to the genus Didymosphaeria and herewith submits the following description:

Didymosphaeria catalpae n. sp. Perithecia very small, scattered, imbedded in the tissue of the leaf, pyriform to nearly spherical, varying in width from 48 - 104 mic. and in depth from 64--140 mic. Ostiolum broadly conical, erumpent. Asci 8-spored, cylindrical, usually somewhat curved, paraphyses few or wanting. Spores oblong-elliptical, hyaline or yellowish, uniseptate, constricted in the middle 9.6—13 x 3—4 mic.

Occurs in leaf spots upon Catalpa sp. the ostiola appearing upon either or both surfaces of the leaf.

In the herbarium were found specimens of two species of imperfect fungi upon Catalpa leaves, *Macrosporium catalpae* E & M on material collected by J. A. Jack, Jamaica Plain, Mass., August 20, 1890, and *Phyllosticta catalpae* E & M collected by H. W. Ravenel, Aiken, S. C., July, 1904. The comparison of this herbarium material with that secured upon the university grounds led to the discovery of conidial spores very similar to those of *Macrosporium catalpae* upon the latter and also upon that labeled *Phyllosticta catalpae* (Fig. 1, 2, 3). It revealed also pycnidia upon the specimens labeled *Macrosporium catalpae* similar to those upon specimens labeled Phyllosticta catalpae and to those upon the leaves obtained upon the university grounds. But upon none of the herbarium specimens did the writer find perithecia. It may be of significance to note that the material secured upon the university grounds was collected just before frost fell and that only the latest developed spots bore perithecia.

* Contribution from the Botanical Laboratory of the Ohio State University, XLV.

In an effort to secure more perithecia from this material a number of spots were cut from leaves that were dried and laid away at the time of collection. These spots were placed in water to soften and after a few hours a part of them was taken out, killed, imbedded, sectioned and stained. Upon one of these spots both perithecia and pycindia were found (Fig. 9) similar to those before discovered upon separate spots—a fact pointing to the probability that both fruiting bodies sprang from the same mycelium. A few of the leaf spots not imbedded were left in the water for several days and when again examined showed a vigorous growth of mycelium which was producing in abundance the chain-like spores of an Alternaria (Fig. 4). A number of other spots similarly treated gave like results. A more thorough investigation of the specimens labeled *Macrosporium catalpae* was now made by soaking some of the spots in water and then mounting them in glycerin. This revealed conidiophores and chain-like spores (Fig 5) similar to those mentioned above, from which it appears that the fungus known as *Macrosporium catalpae* is a species of Alternaria Furthermore, one of the spots from which sprang mycelium bearing spores of Alternaria showed among its conidiophores a perithicium as shown in figure 7.

In July the writer received a supply of infested leaves from Mr. Erwin F. Smith, of the Bureau of Plant Industry, at Washington, D. C., collected from catalpa trees in that vicinity. Upon the spots on these leaves a species of Alternaria was found flourishing and when they were removed from the leaves, placed in a moist watch-glass and covered with a small bell jar a vigorous growth of mycelium sprang up producing an abundance of spores in chains. As far as it was possible to determine by comparison, these spores were in all respects similar to those developed in a similar manner from leaves collected at Columbus. From the spores developed from leaves collected at Washington an artificial culture was made from which a pure culture of the fungus was secured. In August three young catalpa trees with leaves representing all stages of development were thoroughly sprayed with sterilized water in which an abundance of the spores from this pure culture had been placed. These trees were growing in a small court with walls on four sides and were in a thrifty, vigorous condition. The spores were sprayed upon them in the evening of a day on which at about noon a heavy rain had fallen. The next day was warm and cloudy and the moisture sprayed upon the plants in the evening was still visible upon them at noon the following day. The conditions seemed to be exceptionally favorable for the development of the spores yet not a single spot appeared upon the leaves of any of the trees. Spores taken from the same source at the same time and placed upon an artificial medium grew nicely thus showing that

the spores were viable. The stress of other duties prevented a repetition of the experiment and the negative results here secured, throw but little light upon the source of infection.

In addition to the fungi already mentioned as occurring upon the leaf spots of the catalpa, the writer found a species of Epicoccum flourishing upon every spot in the leaves collected at Columbus as well as upon every spot examined in the material taken from the herbarium though it was not abundant upon that labelled *Phyllosticta catalpae.* There is also present on the spots in the leaves collected at Columbus and on those in herbarium specimens labeled *Macrosporium catalpae* a species of Cladosporium, a fungus that, so far as the writer is aware, has not been reported for the catalpa. These two fungi, however, are in all probability soprophytes that have no part in producing the spots upon the leaves The results of this investigation tend to show that the species of Alternaria (=Macrosporium) occurring on the catalpa is likewise a saprophytic form. Therefore, in summing up the work so far as it has been carried the writer is of the opinion that the disease-producing species is *Didymospheria catalpae,* of which *Phyllosticta catalpae* is an imperfect form and that the other species of fungi found upon the leaf spots are saprophytic. Whether or not this is the true relationship existing among these different species of fungi remains still to be proved—a task the writer hopes to find at some future time opportunity to perform.

EXPLANATION OF PLATE XXVI.

The drawings were made with a Spencer microscope equipped with a 3 mm. objective and an 8 x ocular (4 x ocular used with No. 6). All are camera drawings made at table distance; reduced one-half in reproductions. The magnification in the microphotographs was not computed.

Fig. 1. Conidial spores of Alternaria sp. on leaves collected at Columbus.

Fig. 2 Conidial spores from herbarium specimen labeled *Macrosporium catalpae.*

Fig. 3. Conidial spores from herbarium specimen labeled *Phyllosticta catalpae.*

Fig. 4. Conidiophores and conidia developed by placing in water spots taken from leaves collected at Columbus. The number of spores in the chains varied from 5 to 8.

Fig. 5. Chain of spores found on herbarium specimen labeled *Macrosporium catalpae.*

Fig. 6. Ascus of *Didymosphaeria catalpae* drawn from a stained section.

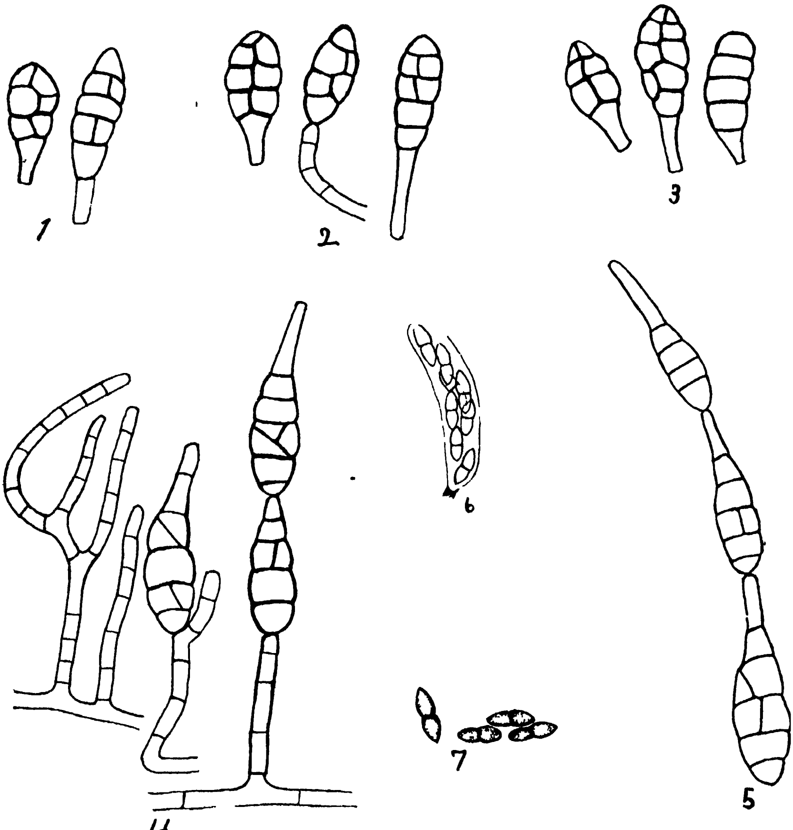
Fig. 7. Ascospores of Didymosphaeria catalpae drawn from stained material.

Fig. 8. Microphotograph of a perithecium in a leaf spot.

Fig. 9. Microphotograph of a section of a leaf spot showing a perithecium of *Didymosphaerium catalpae* at (*a*) and a pycnidium of *Phyllosticta catalpae* at (*b*).

Fig. 10. Microphotograph of section of perithecium from which Figure 6 was drawn.

OHIO NATURALIST. *Plate XXVI.*



PARKER on "Catalpa Leaf Spot."

A NOTE ON AMITOSIS BY CONSTRICTION IN SYNCHYTRIUM.*

ROBERT F. GRIGGS.

In a former article† dealing with amitosis in the parasitic fungus, Synchytrium, the writer mentioned beside the peculiar processes of direct nuclear division which he termed Nuclear Gemmation and Heteroschizis, a third sort of amitosis which resembles closely the more commonly reported process of amitosis where the nucleus elongates and divides by constriction or by the formation of a septum across it. Because he had observed only a relatively small number of such cases at the time of writing the former paper he contented himself with mere mention of the process. Since that time, however, a considerable number of such constricting nuclei scattered through a score of cysts have been found. From an examination of these cases the writer has been fully convinced that this is a normal process which is to be ranked along with the other methods of amitosis in multiplying the nuclei of the parasite preparatory to zoospore formation.

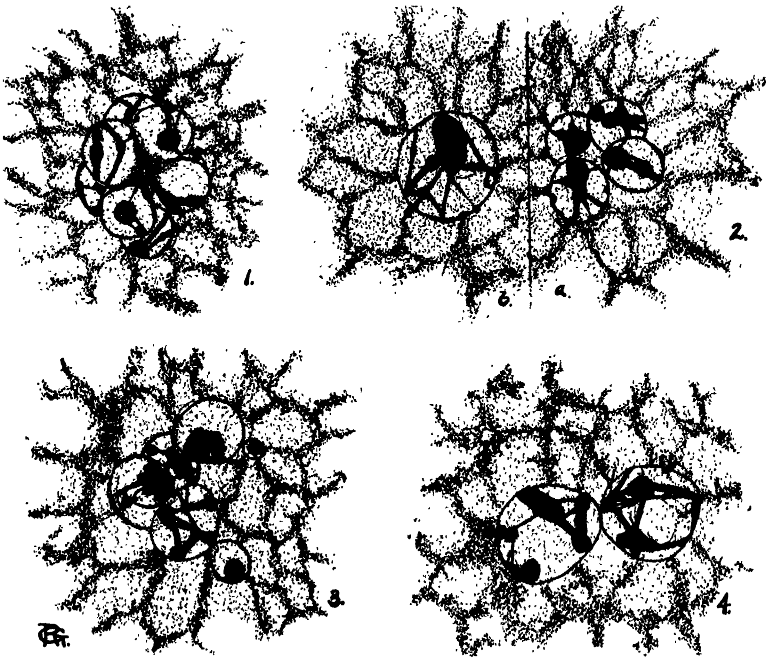
The mechanism by which amitosis is accomplished by constriction is as simple as could well be. Different parts of the chromatin of the nucleus separate and move apart, forming two or more lobes; these round off and each becomes an independent daughter nucleus. This process usually occurs in spirem, but in rare instances neither the daughter nuclei nor the remaining undivided nuclei in the cyst are in that condition. Amitosis by constriction occurs for the most part in early stages when nuclear gemmation is only just beginning and long before heterochizis is observed. Even the primary nuclei may divide in this manner though in the species studied, S. decipiens, they nearly always divide mitotically. Occurring thus early in the cycle of nuclear multiplication this process is usually but an incident in the history of the chromatin thus divided, for after a very brief existence the daughter nuclei are further subdivided by other sorts of amitosis (Figs. 3-4).

It is manifestly impossible to follow the history of the nuclei thus derived by constriction (or their chromatin content) further than their division which is usually accomplished by nuclear gemmation. But evidence was presented in the previous paper which shows that the small nuclei derived by that process are normal and become the ancestors of the zoospores which form

*Contribution from the Botanical Laboratory of the Ohio State University, No. XLVI.

†Griggs, R. F. Some Aspects of Amitosis in Synchytrium. Bot. Gaz. **47**: 127–138, 1909.

the next generation. Inasmuch as healthy normal nuclei could not be formed from parents which were degenerating, that evidence applies to the parents as well as the descendants. In exceptional cases, where they do not immediately fragment, direct evidence of the fate of these nuclei due to amitosis by constriction can'be secured. A few clusters of such nuclei have been observed to persist unchanged until mitosis began. When this occurred they did not behave differently from the other nuclei in any respect but formed spindles like them. In so far, then, as the power to divide by mitosis is a test of the condition of a nucleus, the products of this sort of amitosis must be regarded as normal and similar in all respects to those, if there be any such, which have descended by an unbroken line of mitoses.



In the formation of these nuclei there is apparently no opportunity for the chromatin to be exactly equationally divided as in mitosis. An inquiry into the number of chromosomes occurring in mitoses following such divisions becomes therefore of primary interest in view of the great importance now being accorded to the number of chromosomes in our theories of heredity. In studies along this line which the writer hopes to publish shortly he expects to present evidence indicating, that in spite of the

apparently random division of the chromatin in amitosis the number of chromosomes in the species studied is constantly four. Moreover, in some of the spindles in clusters of nuclei undoubtedly formed by amitosis, the same number is clearly shown. The bearings of these observations except as they tend to demonstrate that amitosis by constriction is a normal process may, however, be left for discussion in the fuller paper which is to follow.

The figures are camera drawings made with 1.5 mm. objective and an ocular 12. They are enlarged 2130 times.

Fig. 1. A large nucleus constricting into a cluster of nine or ten daughters.

Fig. 2. (a) A cluster of daughter nuclei, constriction complete. (b) One of the adjacent parent nuclei of the same cyst.

Fig. 3. A cluster simliar to Fig. 2, but beginning to give off small nuclei by nuclear gemmation.

Fig. 4. A similar cluster of two daughter nuclei.

THE BEDFORD FAUNA AT INDIAN FIELDS AND IRVINE, KENTUCKY.*

Aug. F. Foerste.

The stratigraphic succession of the chief divisions of the Waverly in Ohio, in descending order, is:

6. Logan formation, chiefly sandstones.
5. Black Hand formation, sandstones, often coarse, and locally conglomeratic.
4. Cuyahoga formation, sandstones and clay shales.
3. Sunbury formation, fissile black shales.
2. Berea sandstone, often ripple marked.
1. Bedford clay shales, locally with sandstones.

In 1888, Mr. E. O. Ulrich, in the fourth volume of the Bulletin of Denison University, identified from the Upper Waverly of Ohio sixteen species of bryozoans which occur also in the Keokuk of Kentucky, Illinois and Iowa. Of these, eight are found at King's Mountain, Kentucky, in strata identified by Ulrich as Keokuk, and two other species are closely related to forms found at that locality. From this it is evident that the upper Waverly, now known as the Logan formation, is closely related to the strata exposed at King's Mountain, and that both are approximately equivalent to the Keokuk of the Mississippi Valley.

In a paper read before the Geological Society of America, at Baltimore, in 1908, Prof. Stuart Weller expressed the conviction that the richly fossiliferous strata exposed at the Button Mold

*Published by permission of Professor C. J. Norwood, Director of the Kentucky Geological Survey.

Knob, seven miles south of Louisville, Kentucky, were closely related to the upper Kinderhook, as exposed in the Mississippi Valley. Since these layers at the Button Mold Knob belong to the strata known in Indiana as the New Providence shales, and since the equivalent of these strata lies at the base of the Cuyahoga section in east-central Kentucky, it is probable that those parts of the Waverly which underlie the Cuyahoga also are approximately equivalent to various parts of the Kinderhook section in the Mississippi Valley. From this standpoint, the Bedford may be regarded for the present as a lower Kinderhook horizon.

During the summer of 1908, Mr. W. C. Morse and the present writer were engaged, under the auspices of the Kentucky geological survey, in tracing the lower Waverly formations southward from the Ohio River. In the course of these investigations it became evident that even in the first county south of the river, Lewis County, the Berea lost its distinguishing feature as a series of distinct sandstones, strongly ripple marked, and no longer could be readily distinguished from the underlying Bedford.

For the attenuated part of the Bedford and Berea section, the term Bedford-Berea is employed temporarily.

In the east-central part of Kentucky, at Indian Fields and Irvine, where the Bedford-Berea section does not exceed one foot in thickness, a number of fossils have been found, and since very little is known, so far, of the paleontology of the Bedford-Berea section either in Ohio or Kentucky, the following notes are here appended.

In the fourth volume of the Bulletin of Denison University, in 1888, Prof. C. L. Herrick identified from the Bedford clay shales at Central College, Ohio, the following species:

Lingula melie.
Orbiculoidea newberryi.
Palaeoneilo bedfordensis.
Leda (=*Nuculana*) *diversa–bedfordensis*, var. nov.
Orthis (=*Rhipidomella*) *vanuxemi.*
Chonetes scitulus.
Ambocoelia umbonata.
Macrodon hamiltoniae.
Microdon (=*Cypricardella*) *bellistriatus.*
Bellerophon newberryi or *helena.*
Loxonema cf. *delphicola.*
Orthoceras cf. *linteum.*
Pleurotomaria sulcomarginata.
Goniatites cf. Portage species.
Hemipronites (=*Schuchertella*) sp.
Pterinopecten sp.
Bellerophon lineata.

Of these species, the first two appear to be characteristic of the Sunbury shale. *Lingula melie* was described from the Sunbury shale at Chagrin Falls, 16 miles east of Cleveland, and the types of *Orbiculoidea newberryi* were obtained at the same horizon befow the Cuyahoga Falls, 28 miles southeast of Cleveland. The third species in the list was published originally from the Bedford shales. The following ten species are regarded as either identical with, or closely related to various Hamilton species. The fourteenth in the list is said to resemble a Portage species. No comparisons are made in case of the next two. It is evident that Prof. Herrick was strongly influenced in his identifications by the belief that the Bedford presented an upper Devonian rather than a lower Carboniferous fauna.

In the first volume of the Geology of Ohio, on page 189, Prof. Newberry listed as coming from the Bedford shale, at Bedford, Ohio, *Syringothyris typa* (=*carteri*), *Rhynchonella* (=*Camarotoechia*) *sageriana*, *Orthis* (*Rhipidomella*) *michelini*, *Spiriferina solidirostris*, and *Macrodon hamiltoniae*. From this it is evident that Newberry was impressed with the Waverly affinities of the Bedford. In the second volume of the Geology of Ohio, Newberry listed from the Bedford shale also *Hemipronites crenistria*, *Chonetes logani*, and *Lingula cuyahoga*. In the seventh volume of the Geology of Ohio, Prof. C. L. Herrick expressed the opinion that the fossils listed by Newberry "do not occur in the typical shaly Bedford, but in thin flags associated or interbedded, while the typical Bedford, especially in central Ohio where it reposes directly upon the "Black Shale," carries a considerable series of fossils forming a decided Devonian assemblage. More remarkable still, the specific resemblances are unquestionably with Hamilton (in the broad sense) rather than the Chemung fauna."

In the attempt to determine the equivalence, approximately, of the Bedford shale to horizons already known elsewhere, the resemblances rather than the differences of the Bedtord fauna to other species were noted. The result is that the fauna of the Bedford is still, practically, an unworked field. In the hope of contributing at least a little to our knowledge of the Bedford fauna, the following notes are added. They consist of descriptions of the various forms discovered so far in the attenuated representatives of the Bedford–Berea section, as exposed at Indian Fields and Irvine, Kentucky. For the stratigraphy the reader is referred to the paper on the Waverly formations of east-central Kentucky published by W. C. Morse and A. F. Foerste in the Journal of Geology, March, 1909, page 164.

Lingula irvinensis, sp. nov. (Fig. 7).

Valves gently convex. Concentric striae very fine and close together; of these, 5 or 6 in a length of 2 mm. appear slightly more prominent than the others. Length, 4.8 mm.; width, 4 mm.

Compared with *Lingula melie*, this species is distinctly broader and more oval in form; moreover, all specimens found so far are considerably smaller. Compared with *Lingula meeki* Herrick, the shell is distinctly smaller, the beak is less prominent, appears less attenuated, and the horizon is considerably lower. Rare in the thin representative of the Bedford–Berea at Irvine, Kentucky.

Orbiculoidea sp. (Fig. 12). Compared with *Orbiculoidea newberryi* the apex of the brachial valve appears to be nearer the center; and the pedicel area, though supplied with a strongly elevated, sharp, median ridge, is not supported on a distinctly elevated oval platform, as figured by Hall and Clarke (Volume VIII of the Paleontology of New York) in a typical specimen of *Orbiculoidea newberryi* obtained from the type locality, at Cuyahoga Falls, Ohio. Our shell appears to be related more closely to *Orbiculoidea herzeri*, but the apex of the brachial valve is too central. A small median striation or septum extends forward a short distance from the apex of the pedicel valve along its interior. This is probably a new species, but too imperfectly characterized as yet to receive a name. Concentric striae fine and numerous; some of them, at various intervals, more strongly elevated than others. Outline nearly circular. Lateral diameter about 8 mm. Height of the brachial valve, a little less than 3 mm. In the thin representative of the Bedford-Berea at Indian Fields, Kentucky; not rare.

Orbiculoidea sp. (Fig. 13). The apex of the brachial valve of this species is too far from the center to make it at all likely that this species is identical with the one found at Indian Fields, mentioned above. It is a smaller species apparently, and the concentric striae are less distinct. The largest specimen found has a length of 5 mm. In the thin representative of the Bedford–Berea at Irvine, Kentucky.

Schuchertella morsei, sp. nov. (Fig. 1).

Species of persistently small size. Valves transversely elongate, with the greatest width at the hinge-line. Pedicel valve with a high cardinal area and a prominent deltidium; surface sloping rather evenly from the beak to the margins of the shell, but appearing convex owing to the elevation of the beak. Brachial valve either flat or slightly concave, usually elevated at the beak into a tiny knob. Radiating striae 25 to 30, of which only the alternate striae may be considered as primary, although some of the secondary striae originate near the beak; radiating striae narrow, with wide interspaces, crossed by finer concentric lines, visible only under a lens. Length, 2.6 mm.; width 4.5 mm.; elevation of cardinal area 1 mm.

Abundant in the thin representative of the Bedford–Berea in the northeastern part of Irvine, Kentucky; rare at the same horizon northeast of Indian Fields, Kentucky. Named in honor of Mr. W. C. Morse, in whose delightful companionship the

stratigraphy of the Lower Waverly of Kentucky was unravelled. *Schuchertella morsei* is closely related to *Orthothetes minutus*, Clarke, from the lower limestone in the Marcellus shales of New York, and may be a diminutive descendant of *Streptorhynchus flabellum*, Whitfield, from the Columbus limestone of Ohio. Its relations to *Orthothetes minutus*, Cummings, from the Salem limestone of Indiana, are less evident. Septa and dental plates are absent in the pedicel valve, the hinge area is rather high, but the beak is not distorted and there is no evidence of attachment of the shell by cementation.

Schuchertella herricki, sp. nov. (Fig. 16).

Shell usually transversely elongate, but sometimes attaining a length which is almost as great as the width. The valves were thin and are preserved as strongly flattened specimens which suggest that originally the brachial valve was gently convex and the pedicel valve either flat or slightly concave. In one pedicel valve the arching deltidium and the moderately elevated cardinal area are preserved. The casts of the brachial valve show the impressions made by the crural plates, the posterior border of the flattened cardinal process, and a trace of a median ridge traversing the space occupied by the muscular impressions. Radiating striae narrow and numerous, varying between 5 and 7 in a width of 2 mm., counting both the more prominent striae and those which evidently have been intercalated later. While the difference in size of the radiating striae is readily perceptible under a lens, they appear subequal to the unaided eye. Concentric striae very fine and visible only under a lens. Width of an average specimen, 22 mm.; length, 16 mm.; height of cardinal area, a little over 1 mm.

Abundant in the thin representative of the Bedford–Berea about a mile northeast of Indian Fields, Kentucky, along the road running from the Brownlow Bruner farm on Lulbegrud Creek northwestward toward Kiddville. Named in honor of Prof. C. L. Herrick, whose investigations, on the Paleontology of the Waverly of Ohio contributed materially to our knowledge.

Chonetes sp. (Fig. 10).

A small species, 6.2 mm. in width and 4.5 mm. in length, with 5 to 6 radiating striations in a width of 1 mm. In one specimen, a narrow median striation extends along the base of a narrow median groove from near the beak to within a short distance of the anterior margin of the shell, somewhat resembling a figure of *Chonetes coronata*, published by Hall and Clarke (Volume VIII, Paleontology of New York). Traces of the brachial ridges may be seen, but not enough is known for identification.

In the thin representative of the Bedford–Berea at Indian Fields, Kentucky. Apparently the same species is found in the corresponding layer at Irvine, Kentucky.

Productella sp. Very much flattened impressions of the interiors of the brachial valves of a small species of *Productella*, usually not over 8 mm. in length are not uncommon in the thin representative of the Bedford–Berea at Indian Fields, Kentucky. Much smaller specimens, not exceeding 2.5 mm. in length, found at the same horizon at Irvine, Kentucky, may belong to the genus *Strophalosia*.

Syringothyris sp. A specimen with a short hinge line, as in *Syringothyris typa*, but presenting only the hinge area of the pedicel valve and a few of the immediately adjacent parts of the radiating plications, was found at Indian Fields, in the thin representative of the Bedford-Berea. *Syringothyris typa* is listed by both Newberry and Schuchert from the Bedford shales at Bedford, Ohio.

Ambocoelia norwoodi, sp. nov. (Fig. 2).

Pedicel valve much less arched than in most specimens referred to this genus, although it is not known how much of this may be due to flattening. The beak and umbonal parts projects less conspicuously beyond the hinge line. The median depression is reduced to a narrow groove and widens very little anteriorly. The brachial valve is gently convex; the median depression, narrow near the beak, widens considerably anteriorly, though remaining comparatively shallow. Concentric lines rather inconspicuous. Length of fairly large specimens, 5 mm.; width about the same.

Rather common in the thin representative of the Bedford-Berea at Irvine, Kentucky. Named in honor of Prof. C. J. Norwood, State Geologist of Kentucky, who for many years has been keenly interested in the correllation of the various Mississippian strata of Kentucky.

Camarotoechia kentuckiensis, sp. nov. (Fig. 14).

Sinus of the pedicel valve and the elevated fold of the brachial valve almost imperceptible in most of the specimens at hand. As a rule, the radiating plications occupying these parts of the shell appear slightly narrower and closer together than those lateral plications which occur within a short distance of the latter. Three plications occur in the sinus and four on the fold. The total number of plications is about 16. The slender vertical lamellae supporting the teeth extend well into the interior of the pedicel valve. The presence of a median septum is distinctly shown in casts of the brachial valve. but the evidence of an elongate, narrow, median cavity immediately anterior to the beak is met only occasionally. The largest specimens found so far have a length of about 10 mm. Judging from the flattened valves and the little depth of the sinus of the pedicel valve in our specimens, this species must originally have been one of only moderate convexity.

Rather common in the thin representative of the Bedford–Berea at Indian Fields, Kentucky. Compared with *Camarotoechia marshallensis*, Winchell, this species is flatter, and with a less elevated fold. The beak of the pedicel valves in normal specimens is more elongate.

Camarotoechia sp. (Fig. 11).

A single brachial valve, 16 mm. in length, with 6 plications on the median fold, only slightly elevated above the lateral plications on either side. The number of lateral plications on each side appears to be about four or five. Shells of this type usually are referred to *Camarotoechia sappho*, but in our specimen the plications appear flatter and broader, especially along the fold.

Thin representative of the Bedford–Berea at Indian Fields, Kentucky.

Cypricardella (*Microdon*) sp. (Fig. 4). The outline anterior to the beak is not concave and there is no distinct evidence of an umbonal ridge extending diagonally across the shell as in most specimens referred to this genus; nevertheless, the generic reference is believed to be correct. A small triangular tooth is found at the beak. Both right and left valves, always much flattened, have been found in the thin representative of the Bedford–Berea at Indian Fields, Kentucky. The shell apparently was almost smooth.

Cypricardella (*Microdon*) sp. (Fig. 5). In case of the specimen figured, the outline anterior to the beak is distinctly concave, there is a distinct small triangular tooth at the beak, and posteriorly there is an impression resembling a muscular area which is not found in other specimens evidently belonging to the same species, and whose significance is conjectural. The transversely elliptical form appears to be specific. The absence of any trace of the anterior muscular scar in this and the preceding species is noteworthy. In the thin representative of the Bedford-Berea at Indian Fields, Kentucky.

Nuculana kentuckiensis, sp. nov. (Fig. 6).

Anterior end of shell prolonged beyond the beak in such a manner as to produce a transversely oblong outline, the basal margin being comparatively straight, and the margin anterior to the beak being approximately parallel to the latter. The cardinal margin posterior to the beak concave and inclined as usual. Height of shell, about 4.5 mm.; length, anterior to the beak, about 4.5 mm.; total length, at least 10 mm., possibly a little more, the posterior extremity not being preserved in the specimen which is best preserved.

In the thin representative of the Bedford-Berea at Indian Fields, Kentucky.

Nuclana sp. (Fig. 3). This shell agrees in outline with *Nuculana diversa* of the Hamilton and *Nuculana pandoriformis*, as identified by Hall from the Cuyahoga of Newark, Ohio. A somewhat similar shell was figured by Herrick from the Bedford shale at Central College, Ohio, as *Nuculana diversa*, but it was listed as *Nuculana diversa–bedfordensis*, a new variety. In the thin representative of the Bedford-Berea at Indian Fields, Kentucky.

Macrodon hamiltoniae-irvinensis, var. nov. (Fig. 15). Our specimens belong unquestionably to the group typified by *Macrodon hamiltoniae*, but they do not attain as large a size and the radiating striae are confined to the post-umbonal slopes. Rather common in the thin representative of the Bedford–Berea at Irvine, Kentucky. A much flattened valve of a specimen of *Macrodon* from the same horizon, at Indian Fields, may belong to the same species.

Schizodus sp. (Fig. 8). The generic reference of the specimen referred to this genus is not known to be correct, the cardinal margin being imperfectly preserved. The shell has a general resemblance to *Schizodus cuneus*. In the thin representative of the Bedford-Berea at Indian Fields, Kentucky.

Another specimen of doubtful generic affinities (Fig. 9). bears some slight resemblance in outline to the species described by Hall as *Lunulicardium fragile*, but there is no trace of radiating striae and the species may belong to an entirely different group of lamellibranch shells. In the thin representative of the Bedford–Berea at Indian Fields, Kentucky.

EXPLANATION OF PLATE XXVII.

Fig. 1. *Schuchertella morsei*. A, brachial valve. B, pedicel valve. C, cardinal area of pedicel valve. D, elevation of deltidium over cardinal area. E, transverse section with pedicel valve on the right. Outline drawing indicating natural size of the specimens. Irvine, Kentucky. Bedford–Berea.

Fig. 2. *Ambocoelia norwoodi*. A, brachial valve. B, pedicel valve. C, outline of shell on lateral view. Also an outline drawing indicating the natural size of the shell. Irvine, Kentucky. Bedford Berea.

Fig. 3. *Nuculana* sp. Right valve. Indian Fields, Kentucky. Bedford–Berea.

Fig. 4. *Cypricardella* (*Microdon*) sp. Right valve, lower anterior outline slightly restored. Size of shell indicated by central cross. Indian Fields, Kentucky. Bedford Berea.

Fig. 5. *Cypricardella* (*Microdon*) sp. Left valve. Extreme anterior outline restored. Significance of posterior impression unknown; it is not found in other specimens. Indian Fields, Kentucky. Bedford–Berea.

Fig. 6. *Nuculana kentuckiensis*, sp. nov. Right valve, posterior extremity restored. Indian Fields Kentucky. Bedford -Berea.

Fig. 7. *Lingula irvinensis*, with outline drawing indicating the natural size of the specimen. Irvine, Kentucky. Bedford- Berea.

Fig. 8. *Schizodus* sp. Generic reference uncertain. Right valve, cardinal outline not preserved. Indian Fields, Kentucky. Bedford- Berea.

Fig. 9. Generic reference uncertain. Left valve. Indian Fields, Kentucky. Bedford–Berea.

Fig. 10. *Chonetes* sp. Brachial valve, interior, natural size indicated by outline drawing. Indian Fields, Kentucky. Bedford–Berea.

Fig. 11. *Camarotoechia* sp. Cast of brachial valve with groove indicating position of median septum. Shell distorted. Six plications on the low median fold. Indian Fields, Kentucky. Bedford–Berea.

Fig. 12. *Orbiculoidea* sp. A, brachial valve, with the impression of the interior at the apical end. B, outline of valve on lateral view. Outline drawing indicating the natural size of the valve. Indian Fields, Kentucky. Bedford–Berea.

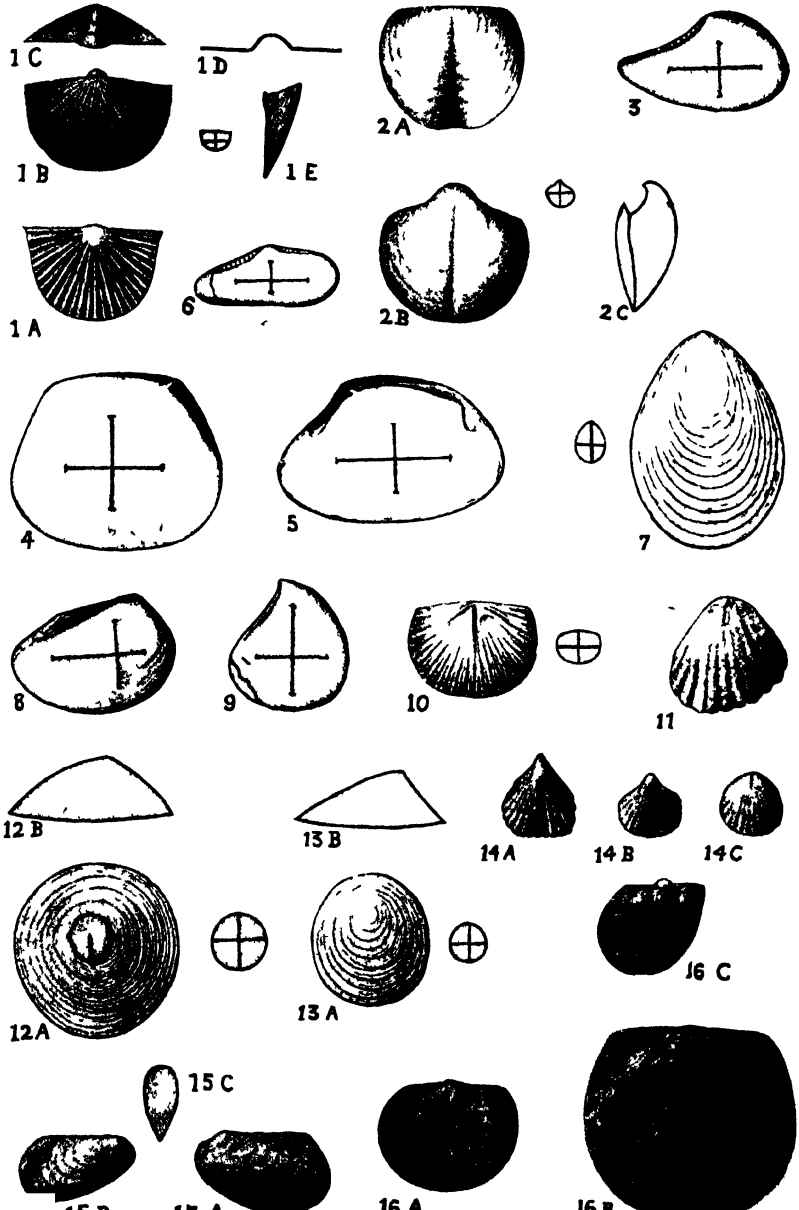
Fig. 13. *Orbiculoidea* sp. Corresponding drawings of a species found at Irvine, Kentucky. Bedford–Berea.

Fig. 14. *Camarotoechia kentuckiensis*. A, B, pedicel valves. C, brachial valve. All casts of interiors. Indian Fields, Kentucky. Bedford–Berea.

Fig. 15. *Macrodon- hamiltoniae- irvinensis*. A, left valve. B, right valve. C, outline drawing to indicate the convexity of the shell. Irvine, Kentucky. Bedford–Berea.

Fig. 16. *Schuchertella herricki*. A, B, brachial valves. C, pedicel valve, showing the cardinal area and deltidium; specimen distorted. Indian Fields, Kentucky. Bedford–Berea.

OHIO NATURALIST. XXVII.



FOERSTE on the "Bedford Fauna."

Meeting of the Biological Club.

ORTON HALL, February 1, 1909.

The club being called to order by the President, Miss Freda Detmers, the minutes of the previous meeting were read and approved as read.

The address of the evening was by Dr. M. B. Lamb, Asst. State Veterinarian, his topic being the Control of Hog Cholera by Serum Immunization. Serum immunization for the control of hog cholera has been developed by the Bureau of Animal Industry at Washington, D. C., and extended by the states. Experimental work in Ohio has been carried on at Reynoldsburg, where 2,000 doses of protective serum have been produced and 700 head of hogs treated with excellent results. This protective serum is probably anti-bacterial as well as antitoxic. To get the serum 500 cu. cc. of virulent blood for each 100 lbs. weight is injected through a vein in the ear. The animal is then bled from the tail and from a 150 lb. animal 150 doses of the protective serum is secured. The blood is defibrinated and a small amount of antiseptic added. The dose is of virulent blood 2 cu. cc., serum 20 cu. cc. for each 50 lbs. weight. This is supposed to last for about four months, and is known as the serum simultaneous method. Where a herd has already become infected, the serum alone is used. The cost of producing the serum per maximum dose for a 50 lb. animal is about 32 cents.

In the discussion that followed Dr. D. S. White, Prof. F. L Landacre and Dr. Chas. B. Morrey took part.

Miss Mary Edmonds and Miss Frances Freeman, advanced students in botany, were elected to membership. Prof. Osborn suggested a commemoration of the centenary of Chas Darwin's birth and moved that the officers of the club be authorized to arrange a special program.

ARTHUR H. MCCRAY, *Secretary.*

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TABLE OF CONTENTS.

A STUDY OF OHIO FORMS OF THE GENUS LEPIDOCYRTUS.*

ALMA DRAYER JACKSON.

The following paper gives the results of a study of the Ohio forms of the genus Lepidocyrtus, including notes on the classification, a discussion of the geographical distribution, and observations on the life history.

My studies were carried on at the Ohio State University under the direction of Professor Herbert Osborn, whose kind assistance has been greatly appreciated. Thanks should also be given to Professor J. W. Folsom who has read and criticised the paper.

A review of the literature on the family Entomobryidae has shown but little work done on the genus Lepidocyrtus except in the description of species. For this reason a special study of the Ohio species has been attempted with the hope of being able to add some notes of interest on the life history.

The habits of Lepidocyrtus are much the same as for other Collembola generally frequenting damp situations. A favorite locality seems to be underneath the bark of old trees, or among dead leaves and under stones. An exception to this is found in the case of L. cephalopurpureus Harvey, which was found in stored celery. Lepidocyrtus may be taken throughout the year, in winter being found deep beneath the fallen leaves. As a rule they are very active, and are found living either solitary or in colonies. Our North American species range in size from 0.6 to 1.5 mm. in length.

* Contributions from the Department of Zoology and Entomology of the Ohio State University, No. 31.

Color has been used extensively in classifying these insects, but this affords a rather unreliable basis for identification. It is true the color patterns are so permanent in some groups of insects as to become almost a structural character, but it is impossible to give the color such weight in this particular case although many writers have given little else in their identification of certain species of Lepidocyrtus. Color is evidently an especially unstable character in this genus on account of the iridescent scales. The opalescent effect never appears the same under two varying lights, and even though the general tone of the insect may be dark or light, it is often very difficult to say just what the most uniform color of the specimen may be. If, however, the structural characters of the antennae, eyes, claws and spring, and the length of the adult insect are given, there should be little trouble in the identification. Not that the color should be disregarded but rather that the greater importance of the structural features should be emphasized. It is the lack of these important characters that makes it impossible to formulate a key to the genus.

The genus Lepidocyrtus was proposed by M. L'Abbé Bourlet in his "Mémoire sur les Podures" published in 1839, for that group of the Linnaean genus Podura having, "Antennes courtes, de quatre articles, huit ocelles," and "couvertes d'écailles." Not all of the genera proposed by M. Bourlet at that time were accepted, but Lepidocyrtus was, and has been retained until the present time.

Classification:—The distinguishing characters of the genus Lepidocyrtus as it is recognized to-day are the projecting mesonotum, the short, four-jointed antennae, and the presence of scales. The number of ocelli has been given as characteristic, but this cannot be depended upon.

In the dorsal view of L. luteus n. sp. the head is almost entirely concealed, while in L. purpureus Lubbock the pronotum projects but little. The character of the scales and of the antennae may be considered as constant, but it is sometimes a difficult matter to distinguish between the projecting mesonotum of a Lepidocyrtus, and that of Seira which differs from the former genus only in not possessing the projecting mesonotum. The gradation between the two is so gradual that this character often proves quite unsatisfactory, for which reason it is necessary to take other characters into consideration in the determination of certain species.

The antennae are comparatively short throughout the genus, never being so long as the body. An examination of numerous forms has shown that the number of the ocelli in the eye spot may range from a single ocellus to as many as eight. The

abdomen is long and cylindrical, the fourth segment being about three or four times as long as the third. The dentes are usually serrated, while the mucrones end in the characteristic incurved hook, with a middle tooth nearly as large as the terminal one. There may be also one or two spurs attached above these teeth. A tenaculum is present and lies in a groove underneath the spring.

Most of the species of this genus bear two teeth on the larger claw of the foot and none on the smaller. However in some cases, we find but a single tooth on the larger one. The iridescent scales form a secondary character in classification, as does also the color of the insect, which is so dependent upon the reflection of light on the scales.

Club-shaped hairs may be borne on various parts of the body. On the anterior edge of the mesonotum of some species is a characteristic collar of these club-shaped hairs, sometimes extending over the head for a considerable distance. Tenent hairs are usually present on the tibia, and very long unknobbed hairs are scattered over other parts of the body. Both the long and short hairs are often distinctly fringed.

GEOGRAPHICAL DISTRIBUTION:—As a group, Collembola may be said to have a general distribution, some species covering a wide range. According to Folsom, Achorutes armatus has been recorded throughout Europe, in the United States, Uraguay, Valparaiso, Siberia, Sumatra and Greenland. We have no such record as this for Lepidocyrtus however. It has been noted that only the more generalized types of Collembola are found in very cold climates, which probably explains why Lepidocyrtus is restricted to the warmer regions, at least within the southern Arctic and Temperate zones, it being among the more specialized types of Collembola. They do not seem to be able to withstand the extreme conditions of the arctic regions but have become specialized to such an extent that certain special conditions of moisture, food and temperature are necessary for their existence. Again, it is probable that the somewhat restricted range of Lepidocyrtus is due to the fact that they have small chances for dispersal. Water forms one of the most important means of distribution that Collembola have especially for those forms that are structually adapted for a semi-aquatic life, but I know of no Lepidocyrtus that is thus adapted. In fact, my experience has been to find them in the dryer situations, and unable to withstand an excess of moisture. For this reason they are not likely to be carried far by water.

It is not probable that the wind can be a very important factor in carrying Lepidocyrtus. Their habit of secreting themselves in the fallen wood, etc., reduces the liability of such trans-

portation to a minimum. They have no wings, and so would not be apt to be caught by the wind and carried for long distances as many other insects are.

Two factors may possibly enter into the distribution of members of the genus. A number of species of Entomobryidae have been found in bird's nests, and it is quite possible for Lepidocyrtus to be transported from one locality to another on the material used for building the nests. Another means of dispersal is upon articles of commerce of various kinds, especially on any sort of goods that would afford them some moisture and a vegetable food supply. Probably the most important factor in this connection would be the shipment of logs and lumber products from one section of the country to another.

In the genus Lepidocyrtus we have many examples of protective coloration. The iridescent scales reflect the general color of the natural surroundings to such an extent that the insect may be easily overlooked. If a specimen of L. pusillus just after molting chances to be on the surface of a dark piece of bark, or on a bit of earth, a very careful search is necessary to reveal it. If in older specimens, in which the bronze tint is more in evidence, the insect happens to be among dead leaves, it is equally well protected.

It is certainly not a very difficult matter for Collembola to adapt themselves to their surroundings and food, requiring, as they do, such simple conditions for their existence that they can live almost anywhere provided they have the required amount of moisture. Still, as regards food habits, there is some degree of preference shown. Some of the Smynthuridae frequent moss, cucumber vines and toad stools; many other Collembola as Isotoma, Poduridae, and Aphoruridae, may be adapted to live on the surface of the water, while other species may be found in almost any locality furnishing decaying vegetable matter and moisture. Lepidocyrtus show no great specialization in food habits, although I have found L. pusillus and L. purpureus most abundant under loose bark, or bunches of dead leaves in dryer localities. On the other hand, some of the lighter colored species are found almost exclusively in loose, damp earth.

At present, the center of dispersal of North American Lepidocyrtus cannot be located, owing to the vast range of territory not yet studied.

The chances for the distribution of the old world species in America are certainly small in comparison with those of other insects. It is more likely their habits than the absence of wings that so limits their possibilities of distributions. For this reason it is not surprising that the number of new species is constantly being added to as new territory is worked.

DESCRIPTION OF OHIO SPECIES:—No attempt has been made to give a complete bibliography of the species, only the original and the principal American works being cited.

LEPIDOCYRTUS PUSILLUS (Linn.) Pl. XXVIII.

1767. Podura pusilla Linn. Syst. Nat. Vol. XII. II, pg. 1014.
1873. Lepidocyrtus pusillus. Packard. Syn. Thys. Essex Co., Mass. pg. 37.
1891. Lepidocyrtus pusillus. MacGillivray. Canad. Ent., Vol. XXIII, pg. 272.
1903. Lepidocyrtus pusillus. Guthrie. Coll. of Minn., pg. 88.

(Description taken from living specimens.)

Color: bluish-bronze or copper, varying from a yellowish tinge in some specimens to bright iridescent blue in freshly molted ones. The prevailing color is bronze, but the scales are so brightly iridescent that the same specimen may at one time appear bronze, at another blue. Antennae: blue, basal segment more yellowish in tint; the blue color of the antennae always retained in mounted specimens; basal segment short, II and III of the same length, IV not quite so long as II and III taken together. Eyes: black; six, possibly eight, ocelli; eye spots plainly visible from dorsal surface at bases of antennae. Various long hairs are found scattered over the body. A long bent hair is situated on either side of abdominal segments IV and V. Mesonotum in dorsal view a little over three times as long as metanotum. Abdominal segment IV, four and one-half times as long as III. Legs: tarsi with two claws, both curving in the same direction; two teeth on larger claw, the distal one just opposite the apex of the smaller claw, the other midway between the distal tooth and the base of larger claw; long hairs present on both femur and tibia. Spring: tinged with blue, mucrones nearly white; manubrium quite a little shorter than dentes, very hairy, dentes long, slender, curved at apex, with sub-annulations on ventral surface; mucrones with two hooks, the apical one long and slender, a spur extending from base of mucrone to opposite point of anteapical hook; two long, barbed hairs extending from dentes to below end of mucrones; other long, curved hairs found scattered over dentes. Length 1–1.5 mm.

Habits: rather a solitary species, quite common among dead leaves, and under bark, but not in as wet situations as many Collembola. When a jar containing dead leaves and rotten wood is brought into the laboratory these insects almost invariably collect in the dryer material on top. If kept in a cell with an excess of moisture they soon die. One specimen measuring 1.5 mm. was kept in a little earthen cell covered with a watch crystal for two months, from the first of March until the first of May. Before molting it appeared decidedly bronze to the naked eye, but afterwards the blues and purples were quite noticeable. Molting took place about every seven or eight days. So many varying descriptions of this species occur with contradictory characters that it is quite impossible to be positive as to the proper identification of specimens. The mesonotum does not project as it does in the extreme forms of Lepidocyrtus, although the head is always partially concealed. We believe

that but one other species is liable to be confused with L. pusillus, this is L. purpureus Lubbock. This species is intensely deep blue, while the third joint of the antennae is shorter than the second, which is not true for L. pusillus.

The Ohio specimens agree very closely with Nicolet's description of L. pusillus, with the exception of the "granular, deep gray antennae," which probably represent only a variation, or a difference in the interpretation of the iridescent reflections. My specimens do not agree with Guthries' description in the "clear, nearly uniform tint of the body," but are rather as Nicolet described the species, "d'un bronze foncé et chatoyant." The antennae are longer in proportion to the body than Guthrie gives them, and the colorless spot mediad to each eye was not noticeable. There seems to be many local varieties of this species, which may account for the confusion in the literature. The bent hairs on abdominal segments IV and V may be broken off in mounted specimens, but are always characteristic of living ones. In fact, the Ohio specimens, if we have correctly identified this species, are at once distinguished by the presence of these bent hairs and the bluish-bronze tint of the body.

LEPIDOCYRTUS PURPUREUS LUBBOCK. Pl. XXIX.

1873. Lepidocyrtus purpureus Lubbock. Monog. Coll. and Thys., pg. 155; pl. XXX.

1903. Lepidocyrtus purpureus. Guthrie. Coll. of Minn. pg. 87.

(Description taken from living specimens.)

Color: to the naked eye a deep, grayish blue, with purple reflections, varying to lighter shades. Under the microscope the color appears a more intense purplish blue. Antennae grayish blue, lighter than body; II nearly twice as long as I; III shorter than II, and nearly one and a half times longer than I; IV over three times as long as I, or nearly equalling II plus III. Eyes: black, eight ocelli. A thick border of clubbed hairs on mesonotum. Fringed hairs are found on the abdomen, legs, manubrium and dentes. Mesonotum in dorsal view almost three times as long as metanotum. Abdominal segment IV three times as long as III. Legs. tibia and tarsi nearly white; coxa, trochanter and femur mottled with blue; the claws are quite characteristic in having a small notch at base of the larger claw, and a slight indentation at the base of the smaller. The ante-apical tooth on the larger claw is opposite the apex of the smaller claw, and the apical tooth a short distance below the ante-apical. Both claws curve in the same direction. True tenent hairs are absent from the tibia. Spring: white; manubrium but little shorter than dentes; the sub-annulations on the dentes not so deep as in some species; apical hook of mucrones more slender than ante-apical; a spur extending from base of mucro to opposite ante-apical hook; long, barbed hairs extending from dentes to apex or slightly beyond apex of mucrones. Total length, 1 mm.

L. purpureus is at once distinguished from L. pusillus the most closely allied form, by the much deeper blue color, the absence of curved hairs on the abdomen, and the relative proportion of the segments of the antennae, III being shorter than

II, which is not true for L. pusillus. The pigment in L. purpureus also presents a decidedly mottled appearance, especially in mounted specimens.

L. purpureus may be synonomous with L. metallicus L. cyaneus and L. iricolor, but according to Packard's description L. metallicus differs in the following respects. The spring is short and thick, the manubrium unusually broad, and the mucrones extra large. It also seems to differ in its blackish-bronze color. As before stated, L. iricolor is not sufficiently characterized to identify with any of these species.

L. purpureus is very abundant about Columbus, and may be found in abundance under loose bark of fallen trees, as well as in the other usual localities for Lepidocyrtus. It seems to live in the confinement of artificial cells about as well as in its natural surroundings. In coloration it is one of our most beautiful species.

LIFE HISTORY OF LEPIDOCYRTUS PURPUREUS. Pl. XXIX. The young of the above species, closely resemble the adults. In color they are a lighter blue, quite silvery to the naked eye, not showing the purple reflections so marked in the adults. The head seems quite out of proportion to the rather slender body. The larvae of L. purpureus are remarkedly agile, thus very hard to study alive for structural details. Mounted specimens show every detail of character in the claws, spring and antennae found in the adult, even to a constancy in the arrangement of the hairs over the body. The black eye spots are very noticeable at the bases of the antennae, and plainly visible from above, in contrast to L. sanguineus. From the colonies observed it seems that eighteen to twenty eggs may be produced at one time by this species. Larval forms measure from 0.20 mm. to 0.25 mm. in length.

LEPIDOCYRTUS SANGUINEUS. n. sp. Pl. XXX.

(Description taken from living and mounted specimens.)

Color: white, with iridescent scales, sometimes with a bluish cast. Antennae: segment III shorter than II; IV nearly or quite twice as long as III, or equalling II plus III; length of segments slightly variable; densely covered with short hairs. Eyes: red, unusually small with single ocellus, appearing at side of head near bases of antennae as mere specks. Plainly visible on ventral surface. Fringe of clubbed hairs on mesonotum clubbed; various long, barbed hairs scattered over the body, legs and head; four long, barbed hairs are found regularly on both abdominal segments II and IV. Scales rectangular, largest on the manubrium. Mesonotum in dorsal view fully four times as long as metanotum. Abdominal segment IV four times as long as III. Legs: tarsi bear two claws, the larger with two teeth; the smaller claw nearly straight with a slight curve at its tip. A long hair is present on the tibia of each foot, but is not a true tenent hair in function. Spring: manubrium densely covered with hairs and large, broad scales; dentes somewhat longer than manubrium,

bearing serrations which in ventral view appear as sub-annulations; mucrones with two hooks, a spur at base extending out almost opposite ante-apical hook, two long, barbed hairs arising from end of dentes, one extending to end of apical hook of mucrones, the other some distance beyond. Length .7–.9 mm.

This small white form is very active, and found commonly about Columbus in the cavities of old rotten wood, and among the leaves and dirt. When feeding the head is barely visible under the projecting mesonotum. It is easily distinguished as a small white form, with the bead-like red eyes at the sides of the head, and the short third joint of the antennae. The eyes, however, soon lose their pigment in alcoholic specimens.

This species is especially interesting as a Lepidocyrtus from the fact that it possibly represents the connecting link between Lepidocyrtus and the eyeless genus Cyphodeirus. Guthrie records one species with five ocelli instead of the typical eight to either eye patch (L. decemoculatus) and another (L. sexoculatus) with but three ocelli to either eye patch. L. sanguineus, as the two above named species, has every character of a Lepidocyrtus with the exception of the rudimentary condition of the eyes. When we consider the evidence of such reduction in the other genera, we cannot but feel there is just argument in including such forms with rudimentary eyes in this genus. Again when we consider the gradation in the degree to which the mesonotum projects over the head, and the difficulty in classifying the specimens on this character in some instances, it seems but a step to the genus Cyphodeirus in which the thorax projects but little, and possibly even should be united in one genus.

NOTES ON LIFE HISTORY OF LEPIDOCYRTUS SANGUINEUS. n. sp. Pl. XXX.—On May the twenty-fifth the larval forms of L. sanguineus were first observed. They were found in colonies of eight or ten individuals in the channels of decayed wood made by wood boring larvae. Each colony probably represented the offspring of one parent. The resemblance to the adult forms was very striking, the apparent absence of eyes, and the larger size of the head in proportion to the body being the only appreciable differences. In color the larvae are silvery-white to the naked eye, the same as the adult, with iridescent scales, and very active. The relative proportions of these larvae when first observed may be seen from the following measurements:

	LARVA.	ADULT.
Total length of insect	0.32 mm.	.9 mm.
Width of body	0.09 mm.	.30 mm.
Length of antennal segments I	0.02 mm.	.045 mm.
II	0.03 mm.	.065 mm.
III	0.275 mm.	.055 mm.
IV	0.065 mm.	.115 mm.
Total length of spring	0.17 mm.	.5 mm.
Width of head	0.10 mm.	.2 mm.
Length of head	0.08 mm.	.16 mm.

Still smaller individuals than the above have been found and it is believed that 0.20 mm. would be a good average for the length of freshly hatched larvae.

One week after the larval forms were first noticed the insects averaged 0.40 mm. in length, an increase of not quite 0.10 mm. The eyes were still not visible.

Three weeks later the average length was 0.55 mm. When the forms showed little change other than an increase in size. One specimen, however, was covered with drops of moisture as if just ready to molt. In a short time the skin split along the mid-dorsal line of the thorax, and the old skin was cast off. For the first time in the life of the now probably five week's old larva the very minute, red, bead-like eyes were visible at the sides of the head at the bases of the antennae. In other words, twenty-eight days had elapsed after the larval forms of 0.32 mm. were first observed before there was any sign of eyes. The forms were now positively identified as L. sanguineus.

From the appearance of the eyes of L. sanguineus until the adult stage is reached the growth is very slow. Nearly four weeks after the appearance of the eyes the average length of the specimens was 0.7 mm., which may be considered that of the adult form.

The following table will show in brief the relative growth of the insects from the larval to the adult stages:

	AVERAGE LENGTH OF INSECT.	EYES.
March 25	0.32 mm	Absent.
April 1	0.40 mm	Absent.
April 22	0.55 mm	Present.
May 4 ..	0.575 mm.	Present.
May 19.	0.70 mm	Present.

Specimens of the above species have been kept alive in artificial cells for over ten weeks, but we can not say at present just how long the life of the average individual may be.

Lepidocyrtus Luteus n. sp. Pl. XXXI.

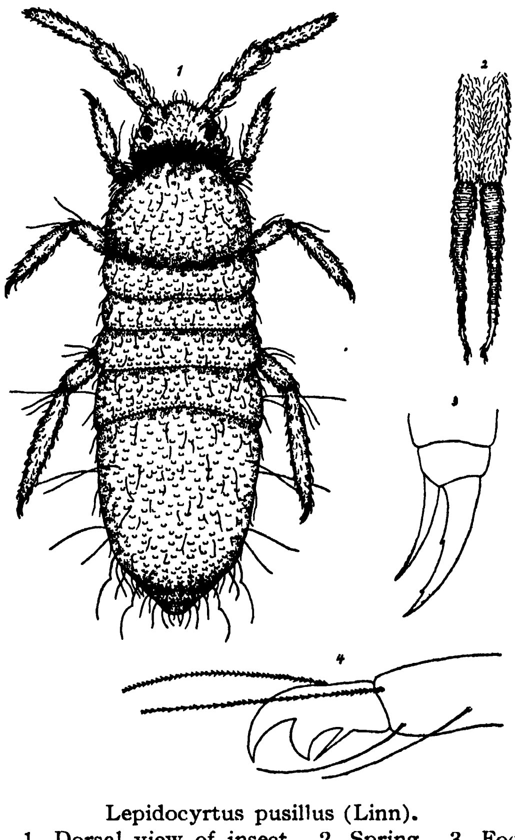
(Description taken from living and mounted specimens.)

Color a light bronze or clay color, with iridescent scales reflecting shades of blue and pink. Antennae I short; II twice as long as I; III shorter than II; IV not quite so long as II plus III. Eyes black, eye spot much elongated, very characteristic in the arrangement of the eight ocelli. A prominent fringe of clubbed hairs on the mesonotum. An extreme type of Lepidocytrus in the strongly projecting mesonotum, which comes to a decided point over the head, nearly concealing the head beneath it. Barbed hairs are found on various parts of the body, scattered over the spring, abdomen and legs. Legs. with two claws, both curved in the same direction; the larger unusually broad and bearing two teeth, the smaller very slender. Abdomen long and slender; IV about seven times as long as III. Spring: manubrium shorter than dentes; dentes sub-annulated; mucrones as usual, with two hooks, and a long spur extending from base to opposite ante-apical hook; long barbed hairs extending to tip and beyond mucrones. Length, 1–1.5 mm.

Found in the same localities and associated with L. pusillus and L. purpureus. This species may be readily distinguished by the bronze color of the body, the extreme type of the pointed, projecting mesonotum, and the peculiar arrangement of the ocelli in the elongate eye spot.

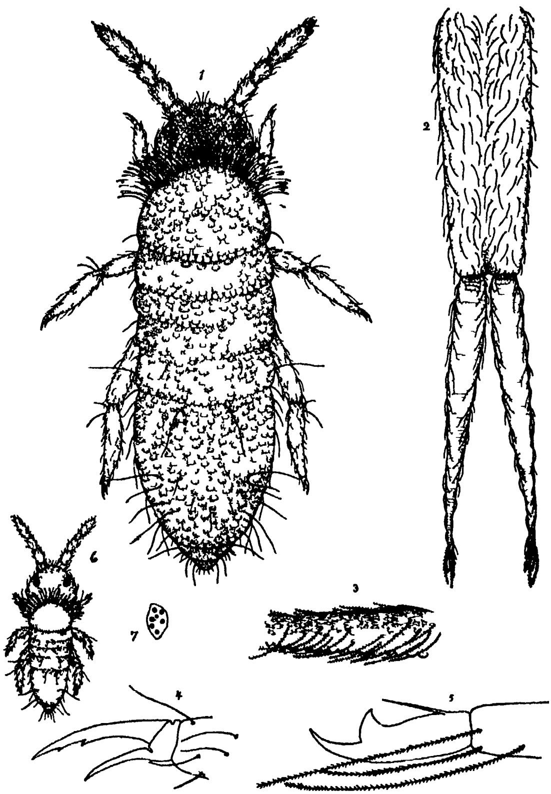
NOTE 1. One other form quite numerous about Columbus has been described as a Lepidocyrtus by Marlatt in 1896, in The Canadian Entomologist, vol. XXVIII, pg. 219, also in U. S. Dept. Agr. Bull., No. 4, pg. 81-83. This species he names L. americanus, however it proves to be synonomous with Seira nigromaculata Lubbock, which has been reported from Minnesota by Guthrie. Superficially the species possibly resembles a Lepidocyrtus, but does not have the projecting mesonotum, while the antennal joints are much longer in proportion than is found among the species of Lepidocyrtus.

OHIO NATURALIST. *Plate XXVIII.*



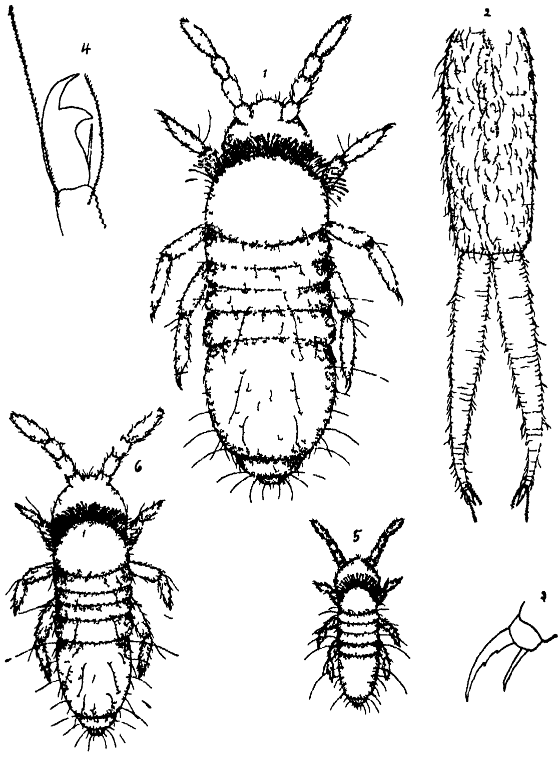
Lepidocyrtus pusillus (Linn).
1. Dorsal view of insect. 2. Spring. 3. Foot.
4. Mucro, showing spur at base and barbed hairs.

OHIO NATURALIST *Plate XXIX.*



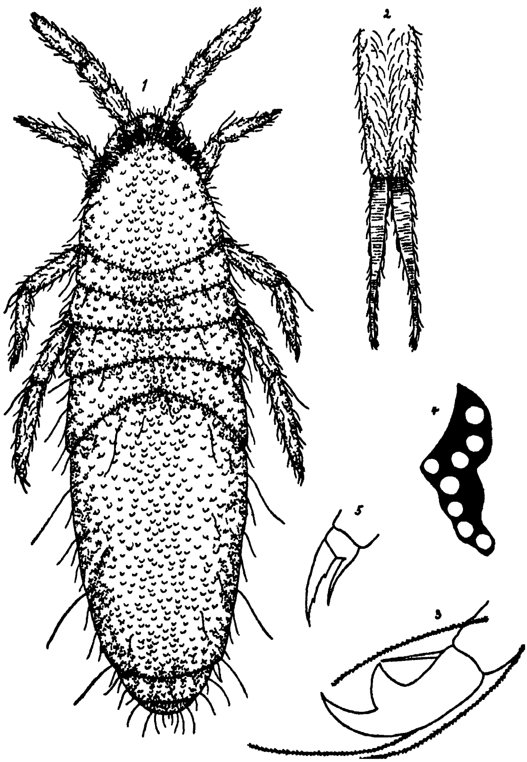
Lepidocyrtus purpureus (Lubbock)

1 Dorsal view of insect 2 Spring 3 Side view of dens showing serrations and barbed hairs 4 Foot 5 Side view of mucro 6 Larval form 7 Eyespot of larval form



Lepidocyrtus sanguineus (Jackson)

1 Dorsal view of insect 2 Spring 3 Foot 4 Side view of mucro 5 Larval form measuring 0.32 mm 6 Same as former, one month later on first appearance of eyes.



Lepidocyrtus luteus (Jackson)
1 Dorsal view of insect. 2. Spring. 3. Side view of mucro. 4. Eye spot. 5. Foot.

THE REDUCTION DIVISION IN THE ANTHERS OF HYACINTHUS ORIENTALIS.*

EDITH HYDE.

There are many problems in connection with the reduction division, which have not been satisfactorily solved. It was, therefore, determined to take up the problem on some plant which would show the nuclear structures as distinctly as possible. The plant finally selected for the investigation was the common hyacinth, Hyacinthus orientalis L.

The dry bulbs of the common hyacinth were planted in the greenhouse at various intervals during the Fall of 1907. A bulb was opened and examined almost every day, but it was not until the first week in November that the desired stages were secured, since it was some time before it was ascertained how long the dry bulbs must remain in the ground before reduction begins. This depends entirely on the time of planting. If the bulbs are put in the ground early in the fall it will be some time before reduction takes place. The desired stages were finally secured in bulbs which were planted in the last week of October, and which remained in the ground less than a week, showing that slow development takes place in the bulb while in the dry state. All of the material killed on the days from the 1st to the 4th of November showed the various reduction stages, and even in the individual bulb nuclei ranging from early microsporocytes to tetrads were found. The usual methods of killing and imbedding were used and the sections were cut from 10–12 mic. thick. The slides were stained most satisfactorily with Delafield's Haemotoxylin. This study was begun under the direction of Prof. R. F. Griggs and was completed under Prof. J. H. Schaffner, to both of whom the writer is greatly indebted for kindly assistance and suggestions.

In the younger anthers many nuclei were found showing the last division previous to the formation of the microsporocytes (figs. 1, 2). In these nuclei the spirems showed a linin thread with definite granules. There is evidently no long resting stage in the sporocyte previous to reduction and this makes it difficult to recognize the young sporocytes from their mother cells, the two being present in the sporangium at the same time. A tendency toward indefinite massing of the chromatin (figs. 3, 4) in the early sporocytes, gradually disappears as the threads of the network become more prominent (fig 5). There does not, however, seem to be any definite massing of the chromatin into

* Contributions from the Botanical Laboratory of Ohio State University, XLVII.

recognizable protochromosomes as in Thalictrum, Agave, and various other plants.

Following this stage the complicated spirem is formed, which gradually thickens until its continuity can be traced with comparative ease, although it is very irregularly looped and twisted (fig. 9). At this stage the so-called synizesis probably occurs. This varies from slight contraction to a dense massing in the center or side of the nuclear cavity. The nucleolus may or may not appear free from the mass (fig. 8). Sometimes series of sections, apparently of the proper stage, do not show synizesis, while in others contractions are present even in well developed spirems.

The spirem continues to thicken and the irregular twisting and winding becomes less complicated, with a strong tendency to form loops, the crossing threads producing a dense mass in the center (figs. 10, 11). This arrangement of the loops with crossing in the center has been noted in other members of the lily family.

No trace could be found of double granules or a split in the spirem. This, however, may have been due to the staining. The linin and chromatin granules appeared quite distinct in the earlier stages (figs. 5a, 9a) but with the twisting and winding prior to the formation of loops, they stain much darker and more uniformly until differentiation finally disappears. The twisting of the spirem now becomes gradually simplified until there are approximately eight loosely rounded loops, the eight incipient chromosomes, corresponding to the reduction number of chromosomes (figs. 12,13). These loops thicken and condense until there are clearly eight loops radiating from the center, with the looped ends pointing outward toward the nuclear wall (figs. 14, 15). The eight chromatin loops were distinctly seen and counted a large number of times.

The arrangement of the spirem into loops, corresponding in number to the reduced number of chromosomes and their subsequent separation and massing to form the chromosomes was mentioned by Schaffner in his paper on Lilium philadelphicum. He found that the "twisted chromatin band arranges itself so as to form twelve loops, the heads of the loops being close to the nuclear membrane." This arrangement was also found by Brown in his study of the embryo-sac of Peperomia. In this case he finds that after the looping becomes more pronounced, the spirem segments, each loop giving rise to a chromosome. He draws the conclusion that chromosomes are, therefore, formed by the coming together, side by side, of parts of the spirem that before were arranged end to end. Gates notes a somewhat similar condition in Oenothera rubrinervis, in which

he finds the spirem varying in thickness in different parts, exhibiting constrictions and dilations indicating more or less clearly where segmentation into chromosomes will take place. He says there is nothing to indicate that the successive chromosomes are members of a pair, but one chromosome frequently swings around and pairs with its neighbor on the skein. He concludes: "We do not really have, then, a transverse division of chromosome bivalents, but a separation of whole (somatic) chromosomes."

One of the most interesting and prominent features in the reduction karyokinesis of the hyacinth is the marked individuality of the bivalent chromosomes. After the formation of the loops, a transverse breaking of the continuous spirem takes place by which they are separated (fig. 16.) The contracting loops show a tendency toward definite size and shape and when the chromosomes have their final form they show a striking individuality. There are two comparatively small chromosomes, a third of medium size and another only a little larger, while the remaining four are of giant proportions when compared with the two smallest. Of the two medium sized chromosomes, one is generally somewhat heart- or v- shaped, while the other is a more or less irregular mass usually without two projecting limbs. Of the four large ones, two in favorable sections, always show a prominent twist while the other two show a more compact and regular form. These shapes and sizes were noted in many different nuclei (figs. 18-22).

Fine threads were often present, extending from the loops to the nuclear wall or connecting the loops themselves. These threads were also present after the separation into chromosomes (fig. 17).

The formation of the spindle and the subsequent stages were not included in the study.

It will be evident from an examination of the figures, that the pairing which takes places in the formation of the bivalent or reduction chromosomes, is between univalents of essentially the same shape, size and activity. There can be little doubt but that these similar conjugating chromosomes represent a pair, the one maternal and the other paternal. The equivalent maternal and paternal chromosomes are, therefore, of essentially corresponding shapes and sizes. To determine definitely by observation whether all the maternal or paternal chromosomes go to a single pole, will require cases in which a difference in character between the two can be determined.

SUMMARY.

1. The chromatin network of the resting nucleus is transformed into a continuous spirem with no definite evidence of the presence of protochromosomes.

2. No spliting or doubling of the linin thread or of the chromatin granules was observed; the chromosomes are apparently arranged end to end in the spirem.

3. Synizesis appeared at various stages but was apparently not constant for any particular stage.

4. The continuous spirem shortens and twists into 8 loops, radiating outward toward the nuclear wall, the crossing threads forming a central knot.

5. The 8 loops break apart at the center to form the 8 bivalent chromosomes.

6. Fine connecting strands often appear between the chromosomes and the nuclear wall or between the chromosomes themselves.

7. The chromosomes show a striking difference as to shape and size.

8. The pair of univalent chromosomes, which must have united to form a bivalent chromosome are alike in shape and size and apparently represent maternal and paternal bodies.

LITERATURE.

Brown, W. H. The Nature of the Embryo-Sac of Peperomia. Bot. Gaz. **46**:445–460, 1908.

Gates, R. R. A Study of Reduction in Oenothera rubrinervis. Bot. Gaz. **46**:1-34, 1908.

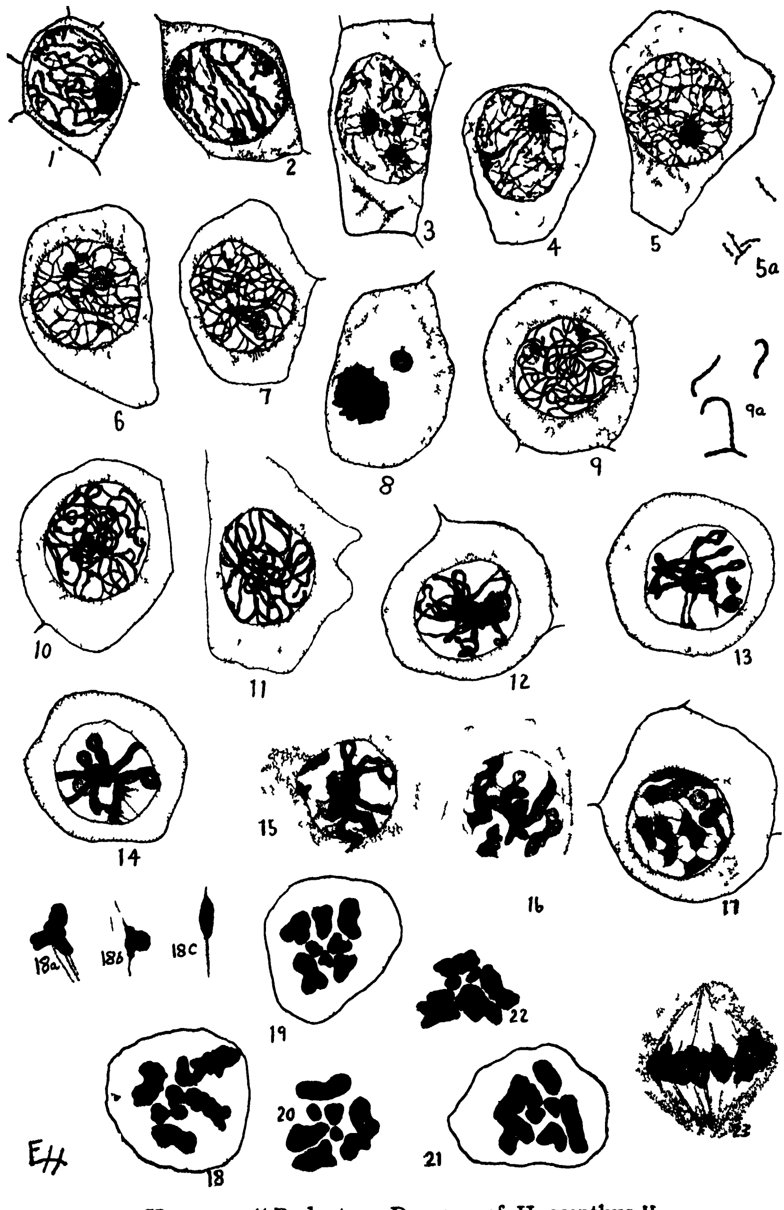
Schaffner, J. H. The Division of the Macrospore Nucleus. Bot. Gaz. **23**:430-452. 1897.

————The Reduction Division in the Microsporocytes of Agave virginica. Bot. Gaz. **47**:198–214. 1909.

EXPLANATION OF PLATE XXXII.

Fig. 1. Mother cell of microsporocytes.
Fig. 2. The same.
Fig. 3. Microsporocyte with chromatin network and showing irregular masses.
Fig. 4. Microsporocyte with delicate linin threads and prominent chromatin granules.
Fig. 5. Microsporocyte with expanding nucleus and more prominent threads.
Fig. 5a. Single threads showing rows of chromatin granules.
Fig. 6. Threads of network adjusting themselves into a definite spirem.
Fig. 7. Spirem becoming thicker.
Fig. 8. Synizesis stage; massing of chromatin.
Fig. 9. Spirem showing irregular twisting.
Fig. 9a. Single threads of same stage.
Fig. 10. Spirem beginning to be thrown into definite loops, the threads crossing and massing in the center.

OHIO NATURALIST *Plate XXXII.*



HYDE on "Reduction Division of Hyacinthus"

Fig. 11. Thicker spirem with loops becoming more definite.
Fig. 12. Spirem adjusting itself into approximately 8 loops.
Fig. 13. Loops more condensed than in Fig. 12.
Fig. 14. The 8 loops distinctly formed.
Fig: 15. Nucleus showing details of two loops.
Fig. 16. Microsporocyte after separation of the loops, before much contraction has taken place.
Fig. 17. Further contraction of chromosomes; connecting threads present.
Fig. 18. Chromosomes beginning to show individuality before complete condensation has taken place.
Figs. 18a, b, c. Types of chromosomes as arranged on spindle.
Figs. 19–22. Chromosome groups showing individual shapes; two large twisted ones, two small ones, and two of medium size, one of which is heart-shaped, also two large ones with no definite shape.
Fig. 23. The chromosomes drawn into the equatorial plane.

Meeting of the Biological Club.

CHEMISTRY LECTURE ROOM, March 1, 1909.

At the regular March meeting of the club, a special program in commemoration of the centenary of the birth of Chas. Darwin was presented. About 200 faculty members and teachers of science in the Columbus and neighboring schools, responded to the printed invitations which were distributed to the members of the club and others. President W. O. Thompson, honorary chairman, not being able to be present, the chair was occupied by Miss Freda Detmers, president of the club. The program was an attempt to cover briefly the many phases of the activity of Darwin in his long and useful life devoted to science.

The following subjects were presented:

1. Darwin's Character and Method of Work, Professor F. L. Landacre
2. The Influence of Darwin's Work in Geology, Professor G. D. Hubbard
3. Darwin's Contributions to Zoological Science, Professor Herbert Osborn
4. Darwin in His Relationship to British Stockmen, Professor C. S. Plumb
5. Darwin's Contributions to Horticultural Science, Professor V. H. Davis
6. The Work of Darwin in Physiological Botany, Professor A. Dachnowski
7. Darwin's Contributions to Botany, Professor J. H. Schaffner
8. Darwin and Modern Philosophy, Professor A. E. Davies
9. Darwin and Modern Psychology, Professor D. R. Major

No business session was held, the entire evening being given over to the reading of the papers.

ARTHUR H. MCCRAY, *Secretary.*

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INDEX TO VOLUMES VII, VIII AND IX.

INDEX TO AUTHORS.

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